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Individuals with neurological diseases are at increased risk of fractures within 180 days of admission to long-term care in Ontario

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Abstract

Background—individuals residing in long-term care (LTC) are more likely to have a fragility fracture than community-dwelling seniors. The purpose of this study was to determine whether the presence of neurological diseases was associated with an increased risk of fracture within 180 days of admission to LTC.

Methods—this retrospective cohort study used data collected in the LTC setting using the Resident Assessment Instrument (RAI) 2.0 during the period from 2006 to 2011 (N = 42,089). Multivariable logistic regression analyses were conducted to determine the associations between the presence of neurological conditions and incident fractures, with and without adjustment for clinical variables.

Results—the incident fracture rate for all LTC residents was 2.6% (N = 1,094). Neurological condition group size ranged from n = 21,015 for Alzheimer's disease or related dementias (ADRD) to n = 21 for muscular dystrophy (MD). The incidence of fracture among residents with specific neurological diseases was as follows: ADRD, 3.2% (n = 672), MD, 4.8% (n = 1), Parkinson's disease, 2.5% (n = 57), stroke, 2.3% (n = 166), epilepsy, 2.5% (n = 38), Huntington's disease, 1.4% (n = 1), multiple sclerosis, 0.3% (n = 1) and traumatic brain injury, 3.8% (n = 11); among the comparison group with no neurological conditions, the fracture rate was 2.0% (n = 366). The neurological diseases that were associated with a significantly greater odds of having an incident fracture in the first 180 days of LTC admission were as follows: ADRD (1.3; 95% CI: 1.1–1.5), epilepsy (1.5; 95% CI: 1.0–2.1) and traumatic brain injury (2.7; 95% CI: 1.4–5.0).

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Conflicts of interest
None declared.

Supplementary data
Supplementary data mentioned in the text are available to subscribers in *Age and Ageing* online.

Conclusion—LTC residents with ADRD, epilepsy and traumatic brain injury are at a higher risk for sustaining an incident fracture in the first 180 days of admission and should be considered for fracture prevention strategies.

Keywords

long-term care; fracture; neurological diseases; older people

Introduction

Half of all hip fractures in Ontario happen in long-term care (LTC) homes [1]. The health-care cost of osteoporosis and associated fractures for Canadians has been estimated at $2.3 billion per year, rising to $3.9 billion dollars if LTC costs are considered [2]. Femur fractures remain one of the leading causes for transfer to acute care from LTC [3]. Clinical variables that place frail older individuals at risk for fracture have been identified [4, 5]. A key barrier to fracture prevention in LTC is the lack of predictive decision support tools, validated for the LTC setting, for systematic identification of individuals at risk for fragility fractures.

Risk factors for fracture may be different in LTC settings compared with those in community-dwelling individuals. LTC residents are often frail and have higher rates of falls than well-elderly in the community [6, 7]. Also, LTC residents who are independent with transfer (e.g. transfer from bed to wheelchair) are at increased risk of fracture [4]. The Public Health Agency of Canada (PHAC)-National Population Health Study of Neurological Conditions (NPHSNC) (http://www.phac-aspc.gc.ca/cd-mc/nc-mn/ns-en-eng.php) has identified 14 neurological conditions as a research priority. A large proportion of individuals admitted to LTC have neurological conditions that may place them at increased risk of fracture; it has been estimated that the prevalence of dementia in Canadian LTC homes is ~56% [8]. Individuals with dementia are more likely to fall and have a higher chance of sustaining a fracture even when the numbers of falls are accounted for [9]. Stroke, dementia and Parkinson's disease have all been associated with fractures in studies of community-dwelling individuals [10–12]; however, there is very little data examining whether LTC residents with neurological diseases are at increased risk of fractures.

The aim of this study was to determine whether the presence of specific neurological diseases was associated with an increased risk of sustaining a fragility fracture within 180 days of LTC admission among LTC residents.

Methods

Design and study population

We conducted a retrospective cohort study of incident fractures in LTC residents 180 days after admission. The study included LTC residents from Ontario who were assessed with the Resident Assessment Instrument (RAI) 2.0 between 2006 and 2011. interRAI assessments are comprehensive, standardised assessments that are used upon admission and on a quarterly basis, to gather information on a wide range of socio-demographic and clinical characteristics [13]. We examined LTC residents on admission; the most recent admission

was used in instances where a resident had multiple admissions (n = 75,369). LTC residents who were coded with end-stage disease (n = 1,002; 1.3%), were bedfast (n = 1,795; 2.4%) or were totally dependent in locomotion (n = 30,483; 40.4%) were excluded from the study sample (n = 42,089). Once the admission records were selected, the Discharge Abstract Database (DAD) and National Ambulatory Care Reporting System (NACRS) databases, developed and maintained by Canadian Institute of Health Informatics, were used to determine the presence of hospital admissions or emergency department visits for fragility fractures. The current project was conducted as part of the Innovations in Data, Evidence and Applications for Persons with Neurological Conditions (ideasPNC) research project, which received ethics approval from the University of Waterloo Office of Research Ethics (project no. 17045).

Neurological diagnoses

Neurological conditions were chosen based on the priority focus of the PHAC-NPHSNC (http://www.phac-aspc.gc.ca/cd-mc/nc-mn/ns-en-eng.php). The conditions that were examined in this study were selected from the disease diagnoses section on the RAI 2.0 assessment and included Alzheimer's disease or related dementias (ADRD), seizure disorders (epilepsy), Huntington's disease, multiple sclerosis (MS), Parkinson's disease, cerebrovascular accidents (stroke), traumatic brain injury (TBI) and muscular dystrophy (MD). Spinal cord injury, amyotrophic lateral sclerosis and cerebral palsy were also considered but were not reported in this article, because there were no incident fractures within these groups within 180 days of admission. In this sample, 12.5% (n = 5,268) had more than one of the conditions, so they were counted in each numerator. The comparison group included all individuals without any of the above neurological conditions.

Incident fractures

International Classification of Disease (ICD)-10 codes were used to identify fractures in the DAD and NACRS databases according to the Revised Framework for National Surveillance on Osteoporosis and Osteoporosis-related Fractures of the PHAC [14]. A resident was coded with fracture (hip (S72.0, S72.1, S72.2), spine (S22.0, S22.1, S32.0, S32.7, S32.8), humerus (S42.2), forearm (S52.x, S62.x) and pelvis (S32.1, S32.3, S32.4, S32.5, S32.7, S32.8)) if there was a DAD or NACRS record with a fracture code within 180 days after admission. One hundred and eighty days were chosen as we were interested in identifying those at highest risk soon after admission. If a resident had an additional fracture after the index fracture, it was not included in the analysis.

Descriptive characteristics of the cohort and clinical variables related to fractures

The RAI 2.0 is performed by trained staff in LTC homes and has established validity and reliability [15, 16]. The following items from the RAI 2.0 were considered for inclusion in the model: age, sex, marital status, previous falls and fractures, self-performance and modes of locomotion, osteoporosis diagnosis, fever, unsteady gait, body mass index (BMI) of <19, recent foot care, physiotherapy and involvement in activities during free time. Scale scores were also reported and were derived from assessment items: Cognitive Performance Scale (CPS) (0–6) measures cognition [17]; Activities of Daily Living Hierarchy (ADL-H) scale (0–6) measures the ability to perform daily tasks [18]; Changes in Health, End Stage

disease, Signs and Symptoms (CHESS) scale (0–5) predicts mortality [19] and Depression Rating Scale (DRS) (0–14) measures signs of depression [20] (Table 1). Lower scores correspond with more intact functioning.

Statistical analyses

Characteristics are expressed as mean and standard deviation (SD) for continuous variables and count and percent for categorical variables. Bivariate logistic regression analyses were conducted on potential co-variates (Table 1) separately to determine whether the variable was significantly associated with incident fractures. Potential co-variates were chosen based on work identifying risk factors for fracture in nursing homes [4] or based on clinical relevance. Variables found to be significant at alpha ≤0.05 in bivariate analysis were entered into multivariable logistic regression models. Two analyses were conducted to determine the associations between the presence of neurological conditions and incident fractures. The first model (simple) included only age and sex as co-variates. The second (full) model adjusted for all of the variables that were found to be significantly associated with fracture (Table 1) except vomiting and history of fractures. When the variables were combined, they were no longer significant and were eliminated. Separate models for conditions with sufficient sample size (ADRD, Parkinson's disease and stroke) were also created using the same methods. Adjusted odds ratios (ORs) and 95% confidence intervals (CI) were reported. Statistical analyses were conducted using SAS version 9.2 (SAS Institute Inc., Cary, NC, USA), with the criterion for statistical significance for the final models set at $\alpha = 0.05$.

Results

The majority of the study cohort ($N = 42,089$) were over the age of 75, and there were slightly more women than men (Table 2). Of those without a condition, 24% were diagnosed with osteoporosis, 36% had a fall in the past 180 days and 10% had a fracture in the 180 days prior to admission. Of those with a neurological condition 180 days prior to admission, 24% were diagnosed with osteoporosis, 34% had a fall in the past 180 days and 5% had a fracture. Fifty per cent ($n = 21,015$) of the total sample had ADRD, 3.6% ($n = 1,497$) had epilepsy, 0.2% ($n = 72$) had Huntington's disease, 0.05% ($n = 21$) had MD, 0.8% ($n = 348$) had MS, 5.4% ($n = 2,275$) had Parkinson's disease, 17.2% ($n = 7,226$) had stroke and 0.7% ($n = 290$) had a TBI.

Of the entire cohort, 2.6% sustained a fracture in the 180 days following admission to LTC. Among individuals without a neurological condition, 2.0% had a fracture. The fracture rate among individuals with a neurological condition in the 180 days following admission was as follows: 3.2% ($n = 672$) of residents with ADRD, 4.8% ($n = 1$) of residents with MD, 2.5% ($n = 57$) of residents with Parkinson's disease, 2.5% ($n = 38$) of residents with epilepsy, 1.4% ($n = 1$) of residents with Huntington's disease, 0.3% ($n = 1$) of residents with MS, 3.8% ($n = 11$) of individuals with TBI and 2.3% ($n = 166$) of residents with stroke.

Individuals with ADRD, Parkinson's disease or stroke had ~1.5 times greater odds of developing an incident fracture within 180 days of admission to LTC compared with individuals without a neurologic condition (Table 3, simple adjusted OR). Individuals with epilepsy had 1.6 times the odds of developing an incident fracture compared with

individuals without a neurologic condition. Individuals with MS had lower odds of developing an incident fracture compared with individuals without a neurological condition (Table 3).

Age, sex, CPS, ADL-H score, falls in the past 30 days, history of fractures, osteoporosis and fracture history combined, locomotion on the unit with help, liver disease, unsteady gait, BMI, physical therapy and time spent involved in activities were all found to be associated with fracture within 180 days of admission. After controlling for these clinical variables related to fracture, the neurological condition variables were added into the model, and the presence of ADRD, epilepsy and TBI remained independently associated with fractures occurring within 180 days of admission (Table 3). See Supplementary data, Appendix 1 available in *Age and Ageing* online for the models created separately for those with ADRD, Parkinson's disease and stroke.

Discussion

LTC residents with ADRD, epilepsy or TBI were at significantly greater odds of sustaining a fragility fracture within 180 days of LTC admission compared with individuals without a neurological disease, even when other clinical variables related to fracture were accounted for. The comprehensive assessment performed on admission to LTC provides a unique opportunity to identify individuals at risk of adverse outcomes and initiate preventative treatment. Our study provides insight on some high-risk subgroups that may need to be considered for fall or fracture prevention strategies.

The finding that the presence of certain neurological disorders may increase the risk of fractures is not new. Meta-analyses have reported that dementia [12] and Alzheimer's disease [21] are associated with an increased risk for hip fracture, possibly due to the increased risk of falls [9]. The risk of fracture is increased after stroke [10] and Parkinson's disease [11], and fracture is a known secondary complication of MD [22]. Girman *et al.* [4] found that dementia might be predictive of subsequent fracture in nursing home residents; however, other neurological disorders are not among the risk factors that have been identified. Existing fracture risk assessment tools proposed for nursing homes have identified factors such as mobility, age, height, weight, independence eating and dressing, urinary incontinence, resistance to care, falls in the past 6 months and ADL to be associated with fractures [4, 5]. This study builds on these previous models with the aim to create a simplified decision support tool for care providers. ADRD, epilepsy and TBI represent high-risk subgroups that may need to be targeted for fracture prevention in the LTC setting. Although not statistically significant, the CI suggest that individuals with Parkinson's disease and stroke may also be high-risk groups.

The 2010 Osteoporosis Canada Clinical Practice Guidelines emphasise the identification and treatment of individuals at high risk of fragility fractures [23]. The guidelines recommend that high-risk individuals should be strongly considered for osteoporosis therapy and non-pharmacological interventions, such as vitamin D, calcium, hip protectors [24–26] and addressing falls risk factors [23]. The most recent version of the guidelines emphasises considering important risk factors in addition to bone mineral density when assessing

fracture risk. However, the risk assessment tools proposed in the Guidelines have not been validated in LTC and may not be appropriate. For example, current risk prediction tools [27] are based on 10-year risk prediction, but most LTC residents do not live for 10 years. There is a need to adapt current risk assessment tools to LTC and to consider important risk factors specific to that setting. Our study has demonstrated that the presence of neurological diseases may need to be considered among those risk factors.

A major strength of this study is that the interRAI data are population-level data covering all persons eligible for services in the sectors using the instruments. The interRAI instruments are designed to function as an integrated health information system that employs a common methodology to assess complex populations across multiple health and social service sectors [28]. They have been consistently shown to have high levels of reliability and validity across multiple care settings [15, 29]. When linked with other clinical data sets, the diagnostic data elements have been reported to have high positive predictive values for neurological conditions (e.g. Parkinson's disease and dementia), and similar findings are reported when using medication prescribing patterns [30]. The (ideasPNC) is the first major study to link interRAI researchers with leading experts in neurological conditions to understand the preferences and needs of persons with neurological conditions across the continuum of care.

This study has some limitations. The sample may not include assessments from all LTC residents in Ontario over the time period studied; full coverage began in 2010, but homes started assessing from 2006 to 2009 as implementation progressed. It is possible that there could be systematic differences between facilities who were early adopters of the RAI 2.0 compared with those who were late adopters; however, it is unlikely. The sample was restricted to Ontario, because DAD and NACRS data are complete for all Ontario hospitals during the 2006–11 time period. Only those fractures that did not result in any contact with a hospital, or where the fracture code was not included, will be missed. Hospitalisations where the fracture code was included based on a fracture that occurred prior to LTC admission are also a potential source of error. We assessed risk of fracture in 180 days, which may represent very high-risk individuals. It is possible that the risk factors for fracture in the short term may be different than those in longer term follow-up. By limiting the study follow-up to 180 days, this study maybe underpowered to find an association between low-trauma fractures and MS, Huntington's disease, MD, SCI, ALS or CP. It is possible that death would present a competing risk; however, we aimed to limit competing risk by limiting follow-up to 180 days and excluded individuals who had end-stage disease, or those who were bedfast or totally dependent in locomotion. Lastly, our findings may not be generalisable to facilities outside of Ontario.

In summary, LTC residents with a diagnosis of ADRD, related dementia, epilepsy or TBI have greater odds of sustaining a fragility fracture within 180 days of admission to a LTC home and should be considered for fracture prevention strategies. Future work should focus on the development of fracture risk assessment tools specific to LTC and to assess the efficacy of fracture prevention strategies in high-risk subgroups.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Key points

- LTC residents with Alzheimer's disease or related dementias are at a higher risk of sustaining a fracture.
- LTC residents with epilepsy, Parkinson's disease and/or stroke are at a higher risk of sustaining a fracture.
- LTC residents with these neurological diseases should be considered for fracture prevention strategies.
- Fracture risk prediction tools designed for LTC should consider specific neurological diseases.

Table 1

List of clinical variables that were found to be significantly associated with fragility fractures within 180 days of admission to LTC

Variable	Odds ratio (95% CI)
Age (reference ≤64)	
65–74	2.36 (1.48–3.77)
75–85	3.28 (2.14–5.02)
85+	4.00 (2.61–6.12)
Female	1.39 (1.2–1.6)
Cognitive Performance Scale (reference = 0)	
1–2	1.13 (0.95–1.35)
3–4	1.53 (1.26–1.85)
5–6	1.89 (1.43–2.5)
ADL[a] Hierarchy Scale (reference = 0)	
1–2	1.28 (1.03–1.61)
3–6	1.18 (0.93–1.5)
Falls in the past 30 days	1.52 (1.31–1.76)
Fractures in the past 180 days	1.27 (1.03–1.59)
Fractures (180 days) or osteoporosis	1.35 (1.19–1.53)
Locomotion on the unit with help	0.77 (0.62–0.97)
Bowel incontinence	0.79 (0.66–0.94)
Liver disease	1.82 (1.03–3.19)
Unsteady gait	1.15 (1.02–1.31)
Vomiting	0.54 (0.29–0.99)
Body mass index < 19	1.5 (1.27–1.78)
Physical therapy	0.87 (0.77–0.99)
Involved in activities	0.79 (0.7–0.91)

For a full list of the variables assessed, see the Supplementary data available in *Age and Ageing* online.

[a]Activities of daily living.

Table 2

Selected socio-demographic and clinical characteristics of the study cohort

	No neurological conditions (*n* = 18,301)	Any specified neurological conditions (*n* = 23,788)
	Frequency (%)	Frequency (%)
Demographics		
Age		
18–65	1,774 (9.7)	1,462 (6.2)
65–75	2,276 (12.4)	2,548 (10.7)
75–85	6,078 (33.2)	9,487 (39.9)
85+	8,165 (44.6)	10,279 (43.2)
Female	12,068 (66)	15,119 (63.6)
Risk factors for fracture		
Fracture(s) in the past 180 days	1,771 (9.7)	1,076 (4.5)
Falls in the past 180 days	6,644 (36.3)	8,037 (33.8)
Osteoporosis diagnosis	4,450 (24.3)	5,756 (24.2)
Fractures (180 days) or Osteoporosis	5,600 (30.6)	6,444 (27.1)
Physical and psychological characteristics		
Cognitive Performance Scale		
0	8,787 (48)	2,187 (9.2)
1–2	7,183 (39.3)	8,829 (37.1)
3–4	2,084 (11.4)	10,434 (43.9)
5–6	247 (1.4)	2,338 (9.8)
Depression Rating Scale		
0	10,813 (59.1)	10,123 (42.6)
1–2	4,729 (25.8)	7,569 (31.8)
3–14	2,759 (15.1)	6,096 (25.6)
ADL Hierarchy Scale[a]		
0	3,294 (18)	2,113 (8.9)
1–2	7,399 (40.4)	9,270 (39)
3–6	7,608 (41.6)	12,405 (52.2)
Mobility		
Cane, walker and crutch	11,620 (63.5)	12,329 (51.8)
Wheelchair primary	6,744 (36.9)	5,142 (21.6)

For a full list of characteristics described, see the Supplementary data available in *Age and Ageing* online.

[a]Activities of daily living.

Table 3

Neurological conditions and their relationship with fragility fractures within 180 days of admission to LTC

Neurological conditions	Age- and sex-adjusted model OR (95% CI)[a]	Fully adjusted model OR (95% CI)[b]
Alzheimer's disease and related dementias	1.53 (1.34–1.76)	1.3 (1.11–1.53)
Epilepsy	1.64 (1.16–2.33)	1.46 (1.02–2.08)
Huntington's disease	1.33 (0.18–9.65)	1.0 (0.14–7.32)
Muscular dystrophy	3.85 (0.51–29.31)	3.83 (0.50–29.49)
Multiple sclerosis	0.25 (0.04–1.82)	0.28 (0.04–2.0)
Parkinson's disease	1.34 (1–1.79)	1.2 (0.89–1.61)
Stroke	1.19 (0.99–1.45)	1.12 (0.92–1.37)
Traumatic brain injury	3.1 (1.66–5.77)	2.67 (1.43–5.01)

[a] Age- and sex-adjusted model adjusted for age and sex.

[b] Fully adjusted model was adjusted for age, sex, cognitive performance score, activities of daily living hierarchy score, falls in the past 30 days, fractures in the past 180 days or osteoporosis diagnosis, locomotion on the unit with help, liver disease, unsteady gait, BMI, physical therapy and time spent involved in activities.