Ten-year trajectories of health care utilization by Manitobans with MS predict nursing home entry

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Abstract

Background

Nursing home (NH) care is expensive and restrictive. Understanding trajectories to NH entry among people with multiple sclerosis (MS) could facilitate monitoring and early risk identification. We investigated 10-year trajectories of health care use in matched cohorts of people with MS who did and did not enter NH, the characteristics associated with trajectory group membership, and whether group membership predicted NH entry.

Methods

We used population-based administrative (health claims) data from Manitoba, Canada, to identify 226 NH entrants with MS between January 2005 and December 2012 and 896 age-, sex- and geographically matched non-NH entrants with MS. Using semi-parametric group-based trajectory approaches, we described trajectories for 5 measures of health care utilization: physician visits, medications, hospital days and their intensity, and home care days. Using multivariable logistic models, we determined whether membership in a trajectory group predicted NH entry.

Results

Mean (SD) age at MS diagnosis was 48.35 (13.25) years for NH entrants and 44.91 (11.58) for nonentrants. Most patients were female (NH entrant, 64%; nonentrant, 61%). Over the study period, trajectories for physician visits and medication use were relatively stable, while trajectories for hospital days and home care increased. High use trajectories for hospital days and medication use were associated with NH entry, while higher use of ambulatory physician visits was associated with a 40%–60% lower risk of NH entry.

Conclusion

Complex patterns of service use and underlying need contribute to NH entry among people with MS. An increasing number of hospital days is strongly associated with NH entry.

Most people with multiple sclerosis (MS) will develop impairments and activity limitations that reduce their ability to meet the demands of daily life. When adequate family or community supports are unavailable, nursing home (NH) entry must be considered for long-term care.^{1,2} In Canada and the United States, 2%–14% of individuals with MS reside in NH.^{3–6}

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NH offer the most expensive and restrictive form of long-term care for older adults and people with disabilities. People with MS want to remain at home^{7,8} but achieving this goal requires proactive monitoring and responses to evolving risk factors. Patterns of health care utilization predict NH entry among older adults,^{9,10} but it is unknown if this is also true in MS. Examining the association between utilization patterns and NH entry risk among people with MS may identify potential monitoring opportunities and times when interventions may reduce risk.

Therefore, we aimed to (1) identify the trajectories of health care utilization over the 10-year period before NH entry in matched cohorts of people with MS who did and did not enter NH; (2) determine what demographic and clinical characteristics are associated with membership in the trajectory groups; and (3) determine if membership in particular trajectory groups predicts NH entry. Based on the literature among older adults,^{9,10} we hypothesized that people with MS who entered a NH would show greater use of services compared to those who did not enter a NH, and that those with greater use would be more likely to have comorbidities.

Methods

We conducted a population-based retrospective cohort study in Manitoba, a Canadian province with a population of about 1.3 million, and a universal, publicly funded health system that subsidizes NH care based on income. Approximately 1% of Manitobans live in a nursing home.¹¹

Data sources

We used administrative (health claims) data held in the Population Health Data Repository at the Manitoba Centre for Health Policy (MCHP), which captures virtually all health system contacts for >98% of the population.¹² We linked (1) the population registry (age, sex, and region of residence based on postal code); (2) medical services (dates of service and diagnoses for ambulatory physician visits based on ICD-9-CM codes); (3) hospital discharge abstracts (hospital admission and discharge dates, most responsible diagnosis, length of stay, and transfers to/from other facilities); (4) Drug Program Information Network (DPIN; date and drug dispensed at community pharmacies); (5) long-term care (date of NH admission); and (6) home care (dates for opening and closing home care services).

Each database has a different start date, the most recent of which is the DPIN, which began in 1995.

Standard protocol approvals, registrations, and consents

Queen's University and University of Manitoba Health Research Ethics Boards approved the study, and approval for data access was received from Manitoba's Health Information Privacy Committee.

Source population

We applied a validated algorithm¹³ and identified 5,422 individuals with MS between April 1, 1984, and March 31, 2012; the date of the first demyelinating disease claim was defined as the MS diagnosis date. Within this group, 246 (4.5%) people were in a NH at any point between January 1, 2005, and December 31, 2012. We selected this time period to allow a 10-year period (1995–2005) of utilization information for all trajectories. In Manitoba, like most of Canada, NH is custodial long-term care not rehabilitative care.

From the remaining individuals with MS, we selected 2–5 matches for the NH entrants based on sex, age (± 5 years), time since first demyelinating disease claim, and region (based on forward sortation area [first 3 digits of postal code]). We excluded individuals with a rehabilitation or chronic care hospital continuous length of stay ≥ 60 days to reduce risk of misclassification, since these long stays often indicate waits for NH placement ($n = 62$). Eleven individuals who were in a NH could not be matched and 9 others with one match were excluded, leaving a final population of 1,122: 226 NH entrants and 896 matches (figure 1).

We estimated that a sample size of 600 (200 cases; 400 controls) would allow detection of a moderate difference in changes over time in health care utilization between the 2 groups, with a power of 0.97.

Health care utilization trajectories

We identified health care utilization trajectories for each outcome using a semiparametric group-based trajectory approach.^{14,15} The 5 outcomes were as follows:

1. Annual number of ambulatory physician visits¹⁶ including all face-to-face physician visits but excluding those during hospitalizations, emergency room visits, or for prenatal care.
2. Total number of days spent per year as a hospital inpatient.¹⁷
3. Resource intensity weights (RIW) of hospitalizations¹⁸ as defined by the Canadian Institute of Health Information based on information provided in the hospital discharge abstract. RIWs measure the relative intensity of resource use for a hospitalization, and reflect diagnoses, procedures, and the hospitalized individual's age and sex. We summed RIW across all hospitalizations each year.
4. Number of different prescription classes dispensed through a community pharmacy¹⁹ in a given year, according to the WHO's Anatomical Therapeutic Chemical Classification System level 4.
5. Total number of days with an open home care file.²⁰

To construct the trajectories, we used the censored normal distribution to model the trajectories for hospital days, RIW of hospitalizations, and home care days to account for floor and ceiling effects. We modeled the other trajectories using

Figure 1 Identification and matching process for analytic cohort

the zero-inflated Poisson distribution to account for the patients who used no services. A quadratic relationship was used to link year to annual outcome data.

All patients were assigned to a trajectory group for each of the outcomes based on their individual probability scores. We compared models with different numbers of trajectory groups using a Bayesian information criterion (BIC), and selected a preferred model based on the BIC, research question, parsimony, theoretical justification, and interpretability.²¹ For BIC, a small value corresponds to a good model with a large log-likelihood value and a limited number of measures.

Factors associated with membership in trajectory groups

We used several multinomial logistic regression models to examine factors associated with membership in specific trajectory groups for each outcome. The log-odds of membership were calculated relative to the lowest amount of service use. We adjusted all models for age (continuous), sex, region (Winnipeg vs non-Winnipeg), MS disease duration from diagnosis (continuous), and income (low vs high). We determined income quintiles by linking postal codes to 2006 Canadian census data. To avoid small cell sizes, the bottom 3 quintiles plus missing values were collapsed to define low income, and top 2 quintiles were collapsed to define high income. Also, the following comorbidities and continuity of care (COC) were considered for all trajectories.

We used validated algorithms for comorbidities based on the ICD-9/10 codes from hospitalizations and physician visits, or prescription claims^{22–25} (table 1). Based on previous research about prevalence and association with negative outcomes in MS,^{26,27} we examined depression, heart disease, acute myocardial infarction, chronic lung disease, diabetes, and

hypertension. We examined temporal changes in the presence of each comorbidity at the individual level over the trajectory period. Although comorbidity as represented by time-varying covariates influenced utilization trajectories, prediction of nursing home entry was not improved when compared to using only comorbidity status at study entry. Therefore, only comorbidities present at study entry were used for parsimony and ease of interpretation.

COC reflects whether or not an individual received $\geq 50\%$ of ambulatory visits over a 2-year period from the same physician (yes/no). For individuals aged 15–59 years, only general practitioners and family physicians were considered. For individuals ≥ 60 years, internal medicine specialists were also considered. Individuals with <3 ambulatory visits over the 2-year period were excluded. The amount of change in COC over time did not warrant the use of a time-varying covariate; only baseline COC was used.

Predicting nursing home entry

We conducted 5 logistic regression analyses to examine how trajectory groups of health services utilization were associated with NH entry. Covariates included age, sex, region, COC, and comorbidities (as above). Findings are presented as odds ratios (OR) and 95% confidence intervals.

All statistical analyses used SAS V9.3 (SAS Institute Inc., Cary, NC).

Data availability

Data used in this study were provided under data sharing agreements only for use at MCHP. The source data are not owned by the researchers or MCHP and cannot be provided to a public repository. Where necessary, source data specific to this study may be reviewed at MCHP with the consent of

The NH entrants used more hospital days and home care days at baseline and throughout the study period compared to nonentrants.

the original data providers, along with the required privacy and ethical review bodies.

Results

The matching of NH and non-NH entrants was successful, although the large cohort size and use of ± 5 years age match produced statistically significant age differences between groups (table 2). The prevalence of comorbidities did not differ between the groups at baseline, but after 10 years, the NH entrants had higher prevalence of diabetes, hypertension, heart disease, and depression. Physician visits and medication use also did not differ between the groups at baseline, but differences emerged after 10 years. The NH entrants used more hospital days and home care days at baseline and throughout the study period compared to nonentrants.

Ambulatory physician visits

For number of physician visits, a 3-group trajectory best fit the data (BIC = 39,736.24; figure 2A), where the distribution of individuals was 36.9% low use, 44.0% medium use, and 19.1% high use.

Individuals were less likely to be moderate vs low users if they were an NH entrant (OR 0.69; 0.50–0.97), but more likely if they were older at MS diagnosis (OR 1.03; 1.01–1.04), experienced COC (OR 1.98; 1.49–2.62), and had depression (OR 3.27; 1.80–5.95) or hypertension (OR 2.20; 1.37–3.54) at baseline.

Individuals were less likely to be high vs low users if they were an NH entrant (OR 0.55; 0.35–0.87), male (OR 0.51; 0.34–0.75), or lived outside of Winnipeg (OR 0.49; 0.34–0.72), but more likely if they were older at MS diagnosis (OR 1.05; 1.03–1.06), had higher income (OR 1.54; 1.06–2.23), experienced COC (OR 2.54; 1.73–3.73), and had depression (OR 8.09; 4.30–15.22) or hypertension (OR 2.68; 1.53–4.67) at baseline.

In multinomial models, more ambulatory physician visits protected against NH entry after adjusting for sex, age at MS diagnosis, COC, region, income, and comorbidities. As compared to low users, moderate users of ambulatory physician services had reduced odds of NH entry (OR 0.59; 0.42–0.85), as did high users (OR 0.40; 0.24–0.66).

Hospital days

For hospital days, a 2-group trajectory best fit the data (BIC = 1,167.5; figure 2B), where the distribution of individuals across these groups was 76.7% low use and 23.3% high use. Findings for the RIW model were similar (data not shown).

Individuals were more likely to be high vs low users if they were an NH entrant (OR 10.39; 7.35–14.67), older at MS diagnosis (OR 1.02; 1.00–1.03), live outside of Winnipeg

Table 1 Definitions used to identify comorbidities from hospital (H) or physician (P) or prescription (ATC codes/DIN) claims data

Comorbidity	Years of data	Algorithm: number and type of claims	ICD codes	ATC codes/DIN
Hypertension	2	≥ 1 H or ≥ 2 P	ICD-9: 401–405	
			ICD-10: I10–I13, I15	
Diabetes	5	≥ 1 H or ≥ 2 P	ICD-9: 250	
			ICD-10: E10–E14	
Heart disease	5	≥ 1 H or ≥ 2 P	ICD-9: 410–414	
			ICD-10: I20–I25	
Chronic lung disease	5	≥ 1 H or ≥ 2 P or ≥ 2 Rx	ICD-9: 493, 491.xx, 492.xx, 496.xx	See e-Methods (links.lww.com/CPJ/A58)
			ICD-10: J45, J46, J40, J42, J43, J44	
Depression	2	≥ 1 H or ≥ 5 P or (≥ 1 P and ≥ 7 Rx)	ICD-9: 296.2, 296.3, 298.0, 300.4	Antidepressants including N06AA01, N06AA02, N06AA04, N06AA11, N06AA12, N06AA17, N06AA21, N06AB03, N06AB04, N06AB05, N06AB06, N06AB08, N06AB10, N06AF03, N06AF04, N06AG02, N06AX06, N06AX11, N06AX16, N06AX21, N06AX23
			ICD-10: F32, F33, F34	

Abbreviations: ATC = Anatomical Therapeutic Classification; DIN = drug identification number; H = hospitalizations; ICD = International Classification of Diseases; P = physician visits; Rx = prescriptions.

Table 2 Demographic and clinical characteristics of study population in December 2012

	In a NH (n = 226)	Not in a NH (n = 896)	p Value
Age in 2012, y, mean (SD)	70.0 (13.9)	66.0 (12.6)	0.0001
Female, n (%)	145 (64.2)	547 (61.1)	0.39
In Winnipeg in 2012, n (%)	134 (59.3)	532 (59.4)	0.98
Age at first demyelinating disease claim, y, mean (SD)	48.4 (13.3)	44.9 (11.6)	0.001
Top 3 income quintiles, n (% at baseline)	41 (40.7)	371 (41.4)	NS
Continuity of care, n (% at baseline)	142 (62.8)	569 (63.5)	0.85
Comorbidities, n (% yes)			
Diabetes (baseline)	11 (4.9)	32 (3.6)	NS
Diabetes (year 10)	41 (18.1)	108 (12.1)	0.02
Hypertension (baseline)	33 (14.6)	108 (12.1)	NS
Hypertension (year 10)	112 (49.6)	330 (36.8)	0.0005
Chronic lung disease (baseline)	7 (3.1)	48 (5.4)	NS
Chronic lung disease (year 10)	44 (19.5)	185 (20.7)	NS
Heart disease (baseline)	10 (4.4)	26 (2.9)	NS
Heart disease (year 10)	46 (20.4)	119 (13.3)	0.01
Depression (baseline)	31 (13.7)	87 (9.7)	NS
Depression (year 10)	74 (32.7)	208 (23.2)	0.003
Service use at baseline, mean (SD)			
Ambulatory physician visits	7.7 (6.6)	7.6 (7.2)	NS
Hospital days	3.4 (14.6)	1.8 (9.6)	0.05
Medications	4.8 (4.0)	4.5 (4.7)	NS
Home care	65.9 (134.1)	22.1 (85.4)	0.001
Service use at year 10, mean (SD)			
Ambulatory physician visits	11.1 (8.1)	8.7 (7.3)	<0.001
Hospital days	47.4 (62.7)	2.1 (9.4)	<0.001
Medications	9.7 (6.4)	6.2 (5.7)	<0.001
Home care	75.9 (112.0)	24.2 (84.8)	<0.001

Abbreviation: NH = nursing home.

(OR 1.57; 1.13–2.17), had higher income (OR 1.90; 1.35–2.66), and had diabetes (OR 2.78; 1.35–5.72) or depression (OR 1.77; 1.10–2.86) at baseline.

In multinomial models, being a higher user of hospital days predicted NH entry after adjusting for sex, age at MS

diagnosis, COC, region, income, and comorbidities. As compared to low users, higher users had increased odds of NH entry (OR 10.93; 7.57–15.78). Similarly, high RIW predicted NH entry relative to low RIW (OR 7.59; 5.13–11.22). Post hoc analysis of the reasons for hospitalization is shown in table e-1 (links.lww.com/CPJ/A57).

Number of prescription classes

For medication classes, a 4-group trajectory best fit the data (BIC = 29,413.34; figure 2C). The lowest to highest use groups comprised 28.2%, 37.3%, 28.4%, and 6.2% of the sample, respectively.

Individuals were more likely to be moderate vs low users if they were an NH entrant (OR 1.73; 1.14–2.63), older at MS diagnosis (OR 1.02; 1.01–1.04), or had hypertension (OR 3.70; 1.88–7.29). Individuals were less likely to be in the moderate use group if they were men (OR 0.72; 0.53–0.97).

Individuals were more likely to be moderate–high vs low users if they were NH entrants (OR 2.57; 1.68–3.98), older at MS diagnosis (OR 1.04; 1.02–1.05), experience COC (OR 1.67; 1.18–2.36), or have hypertension (OR 5.12; 2.58–10.16). Men were less likely to be in the moderate–high use group (OR 0.46; 0.33–0.65).

Compared to the lowest user group, the high user group was more likely to be older at MS diagnosis (OR 1.05; 1.02–1.07), have high income (OR 2.84; 1.54–5.25), or have hypertension (OR 3.70; 1.88–7.29). Men were less likely to be in the high use group (OR 0.42; 0.23–0.76).

In multinomial models, use of more prescription classes predicted NH entry after adjusting for sex, age at MS diagnosis, COC, region, income, and comorbidities. As compared to low users, moderate users had increased odds of NH entry (OR 1.38; 1.01–1.89), as did moderate–high users (OR 2.40; 1.50–3.86). The risk of NH entry did not differ between the highest and lowest user groups (OR 1.10; 0.48–2.38).

Days of open home care

For home care use, a 3-group trajectory best fit the data (BIC = –12,099.39; figure 2D). The lowest to highest use groups comprised 73.9%, 14.2%, and 11.9%, respectively.

Compared to the lower use group, individuals in the moderate use group were more likely to be NH entrants (OR 4.57; 3.10–6.77), older at diagnosis (OR 1.03; 1.01–1.05), and experience COC (OR 1.72; 1.13–2.64), while those in the high user group were more likely to be an NH entrant (OR 8.10; 5.37–12.16) and to experience COC (OR 1.72; 1.13–2.64). They were less likely to be men (OR 0.49; 0.31–0.75).

The multinomial logistic models for home care use did not meet assumptions and we could not evaluate whether a particular home care use trajectory was associated with NH entry.

Figure 2 Graphic depictions of the trajectories for 4 types of health care utilization

(A) Ambulatory physician visits, (B) days in hospital, (C) prescription medication use, and (D) days of home care. Trajectory for resource intensity weights is not shown as it is similar to days in hospital. NH = nursing home.

Discussion

In this population-based cohort study, the prevalence of NH entry was 4.5%, which falls in the low end of previous reports of people with MS³⁻⁶ but is high compared to the general population in Manitoba.¹¹ The NH entrants in our MS cohort were young compared to typical NH residents in the general population, with a greater burden of comorbidities over time compared to peers with MS, consistent with prior Canadian reports.⁵

Despite the large size of the study population and the known variability of MS, we identified relatively few trajectory groups for each of the health care services examined. There were low user groups throughout the entire period for all services. For ambulatory physician visits and prescription medication use, all trajectory groups had relatively stable use throughout the period despite the growing proportion of individuals with comorbidities. However, days in hospital and days of home care were more variable, particularly for the moderate to high user groups. Findings from trajectory modeling supported findings from the older adult literature that health care utilization over time differentiates NH entrants from nonentrants.^{9,10} Membership in trajectory groups reflecting moderate to high use (medications) or increasing use over time (hospital days; RIW) was more likely among NH entrants. Membership in trajectory groups with higher use of physician visits over time protected against NH entry.

Together, the findings regarding hospitalizations and medications may simply reflect that NH entrants had a more aggressive MS course, needed more medically intense interventions over time, and used more medications as part of

symptom management. Since NH entrants had a greater burden of comorbidities by the end of the study period, findings may also indicate the medical complexity of the care of these individuals. This hypothesis is consistent with prior findings that comorbidity affects the risk of hospitalization among people with MS,²⁸ and that comorbidity and polypharmacy are associated among individuals with disability.^{29,30} Regardless of whether high use trajectories reflect aggressive disease or medical complexity, findings suggest that prevention and better management of comorbidities might reduce the risk of NH entry among people with MS. Better management will require guidelines for care,^{31,32} particularly for people with multimorbidity, and consistent communication between members of the health care team.

While NH entrants had a higher burden of comorbidities, rates in nonentrants also increased over time and were still greater than that seen in the general population.³³ Non-NH entrants were more likely to be in the higher use trajectory groups for ambulatory physician visits. Therefore, these visits may provide greater opportunities for regular health monitoring and preventive care, thereby reducing risk of NH entry. This hypothesis is consistent with a Canadian study of older adults.³⁴

Given that continuity of physician care did not differ between NH entrants and nonentrants, understanding why some people had fewer visits is critical. One possibility may be mobility-related impairment.³⁵⁻³⁷ For individuals with MS who use a wheelchair or scooter, access to suitable and affordable transportation options may limit physician visits despite actual need.³⁸ The literature supports this possibility for people with MS³⁹ and the broader population of people

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with mobility impairment.⁴⁰ Our data did not allow us to explore this possibility.

Due to statistical limitations, we could not determine whether home care can or does substitute for NH entry. We were also unable to examine other factors that are known to influence NH entry (e.g., functional status, family support) as variables capturing these factors are not consistently available across regions in our data sources. Despite the data limitations, our findings are consistent with previous literature about the role of health care utilization in NH entry. We used data from one Canadian province with subsidized NH care, potentially limiting generalizability to other regions.

Based on our findings, patterns of health care utilization reflecting consistent low use of physician visits, increasing numbers of hospital days, and consistent moderate to high use of prescription medications over time are red flags for NH entry among people with MS. With the use of electronic medical records, it may be possible to monitor people with MS over time to identify those who are beginning to display these patterns. Given the important role of comorbidities in the trajectory patterns predicting NH entry, we must ask whether policy or practice changes supporting better management of people with MS with multimorbidity could reduce the risk of NH entry. Potential interventions may include practice guidelines for MS care in an ambulatory care context and access to community programs for chronic condition management. Only prospective data will determine the viability of these options moving forward.

Author contributions

M. Finlayson: drafting/revising the manuscript, data acquisition, study concept or design, analysis or interpretation of data, study supervision, obtaining funding. O. Ekuma: study concept or design, analysis or interpretation of data, statistical analysis. G. Finlayson: drafting/revising the manuscript, analysis or interpretation of data. D. Jiang: study concept or design, analysis or interpretation of data, statistical analysis. R.A. Marrie: drafting/revising the manuscript, data acquisition, study concept or design, analysis or interpretation of data, obtaining funding.

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TAKE-HOME POINTS

- People with multiple sclerosis who had more ambulatory physician visits over a 10-year period had a 40%–60% lower risk of nursing home entry at the end of this period.
- People with multiple sclerosis who entered a nursing home at the end of the 10-year period experienced a 43-day increase over baseline in annual hospital days compared to a 2-day increase experienced by those who remained living in the community.
- People with multiple sclerosis who entered a nursing home at the end of the 10-year period acquired greater numbers of comorbidities over time compared to those who remained living in the community.
- Even 10 years prior to nursing home entry, there are significant differences between people with multiple sclerosis who ended up entering a nursing home and those who did not. These differences occur in the annual numbers of home care days and hospital days.

Research Data Repository under HIPC 2012/2013-54. The results and conclusions are those of the authors and no official endorsement by the Manitoba Centre for Health Policy, Manitoba Health, Healthy Living, and Seniors, or other data providers is intended or should be inferred.

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