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One Way Out? A Multistate Transition Model of Outcomes After Nursing Home Admission

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ABSTRACT

Objectives: To understand how the odds of both adverse and positive transitions vary over the course of episodes of care in nursing homes.
Design: Retrospective cohort study of individuals admitted to nursing homes using clinical and administrative Canadian Resident Assessment Instrument version 2 data linked to emergency department and hospital records.
Setting and participants: Adults aged 65 years and older, admitted to nursing homes in Ontario, Alberta, British Columbia, and Yukon Territories in Canada, from 2010 to 2015. The sample involved 163,176 individuals with 1,088,336 RAI 2.0 assessments.
Measures: Data on mortality and hospitalization were obtained from nursing home and hospital records. Multistate Markov models were employed to estimate odds ratios characterizing covariate effects on transitions to different states of health, hospitalization, and death, stratified by day of stay beginning with the initial 90-day period after admission to a nursing home.
Results: The first 90 days of stay after admission were characterized by higher odds of both adverse and positive outcomes after adjusting for numerous covariates. Newly admitted residents had greater odds of becoming worse in health instability, being hospitalized, or dying. However, they also had greater odds of being discharged home or improving in health compared with later stages of the episode of care. These associations varied by the resident's Changes in Health, End-Stage Disease, Signs, and Symptoms (CHESS) scores at the start of each 90-day follow-up period, and CHESS was associated with differential rates of death, hospitalization, and discharge home.
Conclusions/Implications: The initial 90-day period after nursing home placement is one in which the likelihood of both adverse and positive changes is elevated for nursing home residents. Special efforts must be taken after admission to identify and respond to risk factors that may increase the resident's odds of negative outcomes. At the same time, there may be a window of opportunity for the person's transition back to the community after a brief nursing home stay.

Entry into nursing homes is usually assumed to be the starting point of a unidirectional trajectory of decline continuing to death in the facility. As admission criteria focus increasingly on more impaired populations, the expectation is that future stays will ultimately become brief and palliative in nature. However, few studies examine transitions to different health states and care settings that nursing home residents experience over the episode of care. Rather, most research focuses on binary measures of the occurrence of single

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outcomes without attention to diverse alternative outcomes among those not experiencing the main event of interest.

In fact, multiple outcomes are of interest for nursing home residents. Public reporting systems on nursing home quality include indicators of both improvement and decline in functional status and other health indicators.[1–6] Decline may be pervasive, but good quality organizations may also prevent, slow down, or in some cases reverse transitions in health and functional status [eg, activities of daily living (ADL) performance, frailty, depressed mood].

Unnecessary hospitalizations of nursing home residents are of particular interest because of their costs and quality of life implications for frail older adults. Although appropriate medical care should be afforded to any individual, including nursing home residents, some hospitalizations can result in worsened health outcomes, reduced quality of life at the end of life, and unnecessary expenditures of health resources.[7,8]

In addition, some Canadian provinces have established alternative care settings that are intended to provide greater autonomy to persons with lighter care needs at a lower cost of care.[9] US efforts to discharge some nursing home residents to the community have been undertaken because sometimes health and functional status may stabilize or improve enough to allow a return to the community.[10]

Although the rates may vary, there are a multiple potential outcomes for nursing home residents at a given point in time. Therefore, models that can account for multiple transitions in health states and care settings are preferable to those with singular transitions. Indeed, the competing risks for hospitalization and mortality are well understood as potential methodological challenges in longitudinal models.[11]

Risk adjustment or stratification methodologies are also important because nursing home residents are not a homogeneous population.[3] Moreover, different risk factors may affect transitions in different ways. For example, measures of frailty and instability in health predict mortality in nursing home residents,[12,13] but these may also affect relationships with other outcomes of interest.

Finally, few studies examine the trajectories of transitions in health states and service use over the episode of nursing home care; however, transition probabilities and risk factors for transitions may not be fixed over time. Previous research suggests that admission to long-term care may cause considerable distress.[10] On the other hand, for some who are languishing in community settings, a brief episode of facility-based care may help to stabilize health conditions enough to permit a discharge home. The passage of time during an episode of care may increase the probability of death with age, but it may also result in more appropriate care as staff better understand residents' strengths, preferences, and needs.

We used a large, linked Pan-Canadian data set to examine transitions in health instability among nursing home residents who remain in care as well as discharges to home, other residential care settings, hospitals, and death. We examined multiple transitions within a 90-day period using multistate Markov models. We considered numerous covariates in these models, but the 2 key risk factors of interest here are the Changes in Health, End-Stage Disease, Signs, and Symptoms (CHESS) scale measuring health instability[14] and day of stay in the episode of care.

Methods

Data Sources

The Resident Assessment Instrument version 2 (RAI 2.0) is the Pan-Canadian standard for assessing the nursing home residents.[15] It has been adopted by 8 Canadian provinces and is supported by the Continuing Care Reporting System (CCRS) managed by the Canadian Institute for Health Information (CIHI). The RAI 2.0 is completed by trained nurses on admission and every 90 days throughout the episode of care. The instrument contains about 400 clinical variables that can be used to support care planning, outcome measurement, quality improvement, and resource allocation applications.[4,16–18]

Our sample was based on the first episode of care for all persons with a RAI 2.0 assessment in Ontario, Alberta, British Columbia, and the Yukon from 2010 to 2016. CIHI linked those assessments by using the residents' health card number to combine CCRS data with CIHI's Discharge Abstract Database (DAD) to track acute hospitalization and the National Ambulatory Care Reporting System (NACRS) to track emergency department visits. Vital statistics data were not available, but a combination of CCRS, NACRS, and DAD variables reliably tracks deaths in different care settings.

A detailed description of our approach to cohort specification is provided in Supplementary Table 1. We used the first RAI 2.0 assessment for a sample of 163,176 individuals with 1,088,336 subsequent assessments. The main exclusion criteria were first assessment not done at admission; short stay assessments with limited clinical data; assessments done before 2010, and age under 65 years at admission.

We used a 90-day follow-up period for each assessment using subsequent RAI 2.0 assessments, the RAI discharge tracking form, DAD, and NACRS records. For persons remaining in the nursing home with no transitions to other settings in that 90-day period, the next RAI 2.0 assessment identified changes in health instability based on the CHESS scale. We tracked 4 types of transitions out of the nursing home in that 90-day period: discharge home, transfer to other care settings (eg, assisted living), hospitalization, and death. All assessments were retained for longitudinal analyses continuing until the person transitioned out of the nursing home or until March 2015, whichever came first.

Statistical Methods

We used discrete time nonhomogeneous Markov chain models for transitions within a multistate process, as was done in a previous study of rehabilitation outcomes in home care settings.[19] We modeled 7 states based on 3 initial levels of health instability (using CHESS) and 4 transitions out of the nursing home as shown in the state-space diagram provided in Figure 1.

States of health instability were defined for persons in nursing homes: CHESS scores of 0 indicated no health instability (state 1), whereas scores of 1–2 (state 2) and 3 or more (state 3) represent moderate and high levels of instability, respectively. Each of these are transient states since residents can move between them over time, according to whether these are modest or more substantial degrees of improvement (or decline) between assessments. Transitions from states 1 to 2, 2 to 3, and 1 to 3 all represent worsening of health instability among persons who remained in the home. Transitions from states 3 to 2, 3 to 1, and 2 to 1 represent improved stability in health. State 2 can be followed by changes in 2 directions, whereas the only possible changes from states 1 and 3 are worsening and improvement, respectively. This does not limit the ability to use these transitions in a multistate model. State 4 is entered upon a discharge to home, and state 5 is entered upon a discharge to another setting; these are absorbing states because transitions out of the nursing home to those states define the end of the episode of care. State 6 is entered upon hospitalization, and this is also treated as an absorbing state because the responsibility of care is transferred from the nursing home to hospital. Although some hospitalizations are done with a so-called "hold bed," these were not recorded consistently between provinces, so the first transition to hospital was also treated as an absorbing state. State 7 is the final absorbing state, which is entered upon death. In the multistate model, deaths that occurred in the nursing home or emergency department were treated as transitions to state 7, but deaths after admission to hospital were not because the

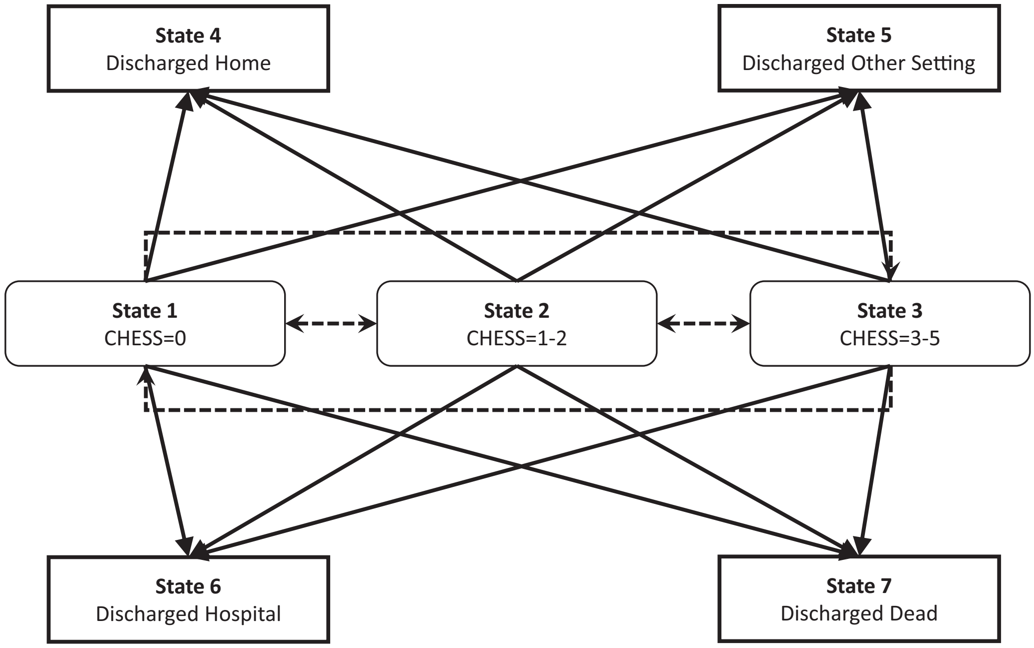

Fig. 1. State-space diagram for possible transitions in multistate Markov model.

transition to hospital occurred first. Note that because the multistate model is comprehensive, it incorporates the fact that transitions among the health instability states (states 1–3) are subject to the semicompeting risks of entering to the 4 absorbing states (states 4–7).[19]

Multistate models of this type can be sensitive to the definition of states, so we examined the impact of defining state 1 as CHESS = 0–1, state 2 as CHESS = 2–3, and state 3 as CHESS = 4–5. With these alternative definitions, 20 of the 72 possible associations had a substantively meaningful change in the adjusted odds ratios: 7 nonsignificant associations became statistically significant, 12 associations became stronger by a 25% relative increment in the odds ratio or more, and 1 became weaker by a 25% relative decrement in the odds ratio or more. There were no instances where a significant odds ratio was no longer significant and there were no changes in the directions of associations. We preferred the original classification of states because it assigned the first state to CHESS = 0, which is a clinically meaningful category of persons with no signs of health instability.

The Canadian reporting standards for RAI 2.0 require that all persons assessed have complete assessment records at the time of admission and every 90 days thereafter until discharge. Therefore, there is no concern with missing data for covariates for any of the longitudinal models used here. The covariates are all baseline characteristics, including age, sex, marital status, facility size, province, cognitive performance,[20] ADL hierarchy,[21] physician visits, diagnoses (chronic obstructive pulmonary disease, pneumonia, diabetes, arthritis, heart failure, renal failure, urinary tract infection, Alzheimer's and related dementias, cancer, depression), advanced directives (do not hospitalize, do not resuscitate), and potential to improve in functional status (based on combined subjective ratings by the resident and by the direct care staff). The main independent variable of interest is the impact of day of stay (ie, how long the person had been a resident at that home) at the time of the assessment using transition years after 1 year of stay as a reference group.

We also fitted cause-specific Cox regression models using the specific dates of different transitions to absorbing states 4–7. We plotted cumulative incidence function estimates of the probability of discharge to home (state 4), other settings, hospital (state 6), and death (state 7) over time in relation to the 3 baseline CHESS states. In this case, we only used admission assessments to illustrate the effect of the initial CHESS on transitions out of the nursing home.

Results

Table 1 shows the distributions of sociodemographic, diagnostic, and functional variables by the 3 states of instability at admission (ie, the starting point for the Markov models). In the overall sample, approximately one-half of the individuals were over 85 years of age, more than two-thirds were female, and most lived in facilities with 100 or more beds. Most had moderate or worse cognitive and ADL impairments, and the most common diagnoses were Alzheimer's and related dementias (61.9%), arthritis (38.8%), depression (23.1%), and heart failure (15.3%). Residents admitted with higher CHESS scores tended to also have higher levels of ADL and cognitive impairment, chronic obstructive pulmonary disease, pneumonia, arthritis, renal failure, urinary tract infections, heart failure, and cancer.

Table 2 shows the transition rates by quarter for transitions out of nursing homes by the raw CHESS score recorded at the beginning of the follow-up and by assessment period in the person's episode. For the initial analyses, hospitalizations with and without subsequent deaths are differentiated. Individuals with higher CHESS scores at the start of any period of risk had a correspondingly higher rate of death in hospital or death in nursing home within the next 90 days. Combined hospitalization rates (with or without death) tend be high for the first 4 CHESS levels, but this effect diminishes over the episode of care and reverses at the highest baseline CHESS level. Although transitions home and to other care settings do occur, these are relatively rare events particularly at later stages of the episode of care.

Table 2 also shows that the probability of remaining in the nursing home after 90 days is lower with each increment in the CHESS score. In addition, the probability of remaining in the nursing home is notably lowest in the first 90 days of the stay, but then generally increases at later stages of the stay. The rate of discharge home is highest early in the course of an admission and at the lowest CHESS levels.

Table 3 shows the adjusted odds ratios associated with assessment period for transitions to 3 health states (CHESS 0, 1–2, 3–5) for those

Table 1
Distribution of Baseline Covariates at Time of Admission to Nursing Home by CHESS Score

Covariates	Level	Ontario, Alberta, and British Columbia			Over all (n = 162,045)
		CHESS = 0 (n = 78,413)	CHESS = 1,2 (n = 73,283)	CHESS = 3-5 (n = 10,349)	
Age group, y	65–74	9506 (12.12)	7331 (10)	869 (8.4)	17,706 (10.9)
	75–84	29,396 (37.49)	25,004 (34.12)	3421 (33.06)	57,821 (35.7)
	85–94	35,039 (44.69)	35,256 (48.11)	5162 (49.88)	75,457 (46.6)
	95+	4472 (5.7)	5692 (7.77)	897 (8.67)	11,061 (6.8)
Sex	Female	48,015 (61.23)	49,578 (67.65)	6803 (65.74)	104,396 (64.4)
	Male	30,398 (38.77)	23,705 (32.35)	3546 (34.26)	57,649 (35.6)
ADL hierarchy scale	0	5707 (7.28)	2275 (3.1)	71 (0.69)	8053 (5)
	1, 2	26,001 (33.16)	15,940 (21.75)	1175 (11.35)	43,116 (26.6)
	3–6	46,705 (59.56)	55,068 (75.14)	9103 (87.96)	110,876 (68.4)
Cognitive performance scale	0	9973 (12.72)	7942 (10.84)	593 (5.73)	18,508 (11.4)
	1, 2	29,890 (38.12)	25,603 (34.94)	2651 (25.62)	58,144 (35.9)
	3, 4	31,394 (40.04)	31,143 (42.5)	5033 (48.63)	67,570 (41.7)
	5, 6	7156 (9.13)	8595 (11.73)	2072 (20.02)	17,823 (11)
Diagnoses	COPD	10,124 (12.91)	14,363 (19.6)	2553 (24.67)	27,040 (16.7)
	Pneumonia	794 (1.01)	1643 (2.24)	579 (5.59)	3016 (1.9)
	Diabetes	20,019 (25.53)	17,955 (24.5)	2521 (24.36)	40,495 (25)
	Arthritis	28,781 (36.7)	29,757 (40.61)	4393 (42.45)	62,931 (38.8)
	Renal infection	7135 (9.1)	8668 (11.83)	1512 (14.61)	17,315 (10.7)
	UTI	5402 (6.89)	7615 (10.39)	1732 (16.74)	14,749 (9.1)
	ADRD	49,365 (62.96)	44,584 (60.84)	6413 (61.97)	100,362 (61.9)
	Heart failure	9230 (11.77)	13,107 (17.89)	2494 (24.1)	24,831 (15.3)
	Cancer	7144 (9.11)	8125 (11.09)	1703 (16.46)	16,972 (10.5)
	Depression	17,031 (21.72)	17,653 (24.09)	2760 (26.67)	37,444 (23.1)
Province	Alberta	9081 (11.58)	13,459 (18.37)	3221 (31.12)	25,761 (15.9)
	British Columbia	13,431 (17.13)	8313 (11.34)	988 (9.55)	22,732 (14)
	Ontario	55,901 (71.29)	51,511 (70.29)	6140 (59.33)	113,552 (70.1)
Facility size	1–49 beds	3586 (4.57)	3324 (4.54)	748 (7.23)	7658 (4.7)
	50–99 beds	20,123 (25.66)	18,447 (25.17)	2495 (24.11)	41,065 (25.3)
	100–149 beds	36,486 (46.53)	33,983 (46.37)	4360 (42.13)	74,829 (46.2)
	150+ beds	18,218 (23.23)	17,529 (23.92)	2746 (26.53)	38,493 (23.8)

who remain in the nursing home after 90 days as well as for transitions to 4 absorbing states: admitted to hospital, died, discharged to other setting, and discharged home. Rows represent the starting CHESS state at the time of the baseline assessment and columns reflect the adjusted odds ratios (95% CI) for each follow-up state. The table shows the adjusted odds for each transition for residents in the first, second, third, and fourth quarter after admission compared with the assessment period 1 year after the admission.

Compared with 1 year after admission, residents in the first quarter were more likely to transition from the lowest to the middle (odds ratio 1.63) and highest (odds ratio 1.23) level of health instability if they remained in the home after 90 days. The same was true for the odds of transition from the middle to the highest CHESS states (odds ratio 1.12), but the effect was weaker. On the other hand, in the middle and high CHESS states at baseline, the odds of improving to more stable health (ie, a lower CHESS state) was also greater in the first quarter after admission compared with 1 year later (odds ratio range from 1.40 to 2.26). Table 3 also shows that the odds of transitions to worse or better CHESS states diminished at later stages of the episode of care compared with the first quarter, such that these odds were effectively the same by the third and fourth quarters of the stay compared with the experience a year or more after admission.

At all baseline CHESS levels, the odds of admission to hospital were greater in each of the 4 quarters of the first year of the stay compared with odds of 1 year or more after the stay (except for CHESS state 3–5 in the fourth quarter, which was not significant). The temporal effect on admissions to hospital tended to be greater for higher baseline CHESS levels, but the odds ratios declined in later quarters after admission.

The odds of death were consistently higher in the first 3 quarters of the episode with the strongest effects for the first quarter after admission. However, the odds ratios were somewhat lower for higher baseline CHESS scores where all groups tended to have higher mortality rates.

Although they were rare events, discharges to other care settings and discharges to home were much more likely to happen in the first 2 quarters after admission compared with 1 year later. However, the effect diminished at later stages in the episode with only baseline CHESS 1–2 having significantly greater odds of discharge to other settings or home compared with 1 year after admission.

Figure 2 provides plots of the cumulative incidence functions for the 4 absorbing states of interest by CHESS scores at admission for a 12-month follow-up period. Although it is a rare event, Figure 2A shows that baseline CHESS scores are strongly associated with the probability of discharge home, with lower CHESS scores having the highest cumulative incidence values over time. Transfer to other care settings is also rare, but it is for the most part unrelated to baseline CHESS scores. Admission to hospital and death are much more common events (Figures 2C and 2D, respectively). Although baseline CHESS score does differentiate the incidence of hospitalization earlier in the stay, the cumulative incidence rates converge at later points in the stay. On the other hand, baseline CHESS scores clearly differentiate mortality over a 12-month period, with higher baseline CHESS scores being associated with markedly higher mortality over time.

Discussion

The initial period after admission to a nursing home is associated with many important transitions, including but not limited to death. Worsening of health instability was more likely, but so was improvement. The odds of dying or going to hospital were higher in the first 90 days (except for the highest CHESS group), as were the odds of going home again or being transferred to another care setting.

Table 2
Ninety-Day Transition Rates to Different Care Settings and Mortality by CHESS Score and Day of Stay at Start of Assessment Period

Status at End of 90-Day Follow-Up	Assessment Period							
	First Year				SecondYear	ThirdYear	Fourth Year	Fifth Year
	First Quarter	Second Quarter	Third Quarter	Fourth Quarter				
CHESS = 0								
Died in hospital	1.4	0.8	0.8	0.7	0.8	0.7	0.6	0.8
Died in nursing home	2.7	1.6	1.5	1.5	1.6	1.8	2.2	2.5
Hospitalized (no death)	9.2	6.7	6.2	5.7	5.4	4.9	4.4	3.5
Discharged home	1.2	0.5	0.3	0.2	0.2	0.1	0.1	0.0
Discharged other setting	0.7	0.5	0.3	0.2	0.2	0.1	0.1	0.0
Remain in nursing home	84.9	89.9	90.9	91.5	91.8	92.4	92.6	93.2
CHESS = 1								
Died in hospital	2.5	1.2	1.2	0.9	1.0	0.9	0.8	0.6
Died in nursing home	6.5	3.6	3.2	3.4	3.4	3.8	4.3	5.1
Hospitalized (no death)	11.3	7.8	7.2	6.8	6.6	5.4	5.0	4.1
Discharged home	1.0	0.4	0.3	0.2	0.1	0.1	0.0	0.0
Discharged other setting	0.7	0.5	0.4	0.2	0.2	0.1	0.1	0.2
Remain in nursing home	78.0	86.5	87.8	88.5	88.6	89.8	89.7	89.9
CHESS = 2								
Died in hospital	3.4	2.1	1.7	1.7	1.2	1.5	1.1	1.1
Died in nursing home	11.6	7.6	7.0	7.0	6.7	6.9	8.2	8.8
Hospitalized (no death)	13.1	9.7	8.8	8.5	7.9	6.8	5.4	6.1
Discharged home	0.8	0.2	0.1	0.1	0.1	0.0	0.0	0.0
Discharged other setting	0.8	0.4	0.4	0.3	0.3	0.2	0.0	0.0
Remain in nursing home	70.2	79.9	81.9	82.4	83.8	84.5	85.2	84.1
CHESS = 3								
Died in hospital	4.1	2.4	2.5	2.2	2.5	1.6	1.7	2.8
Died in nursing home	18.0	16.8	15.9	14.9	13.9	14.7	14.1	17.7
Hospitalized (no death)	12.7	12.1	9.5	9.1	9.0	7.9	7.1	4.9
Discharged home	0.7	0.1	0.1	0.2	0.2	0.1	0.2	0.0
Discharged other setting	0.8	0.5	0.4	0.2	0.2	0.3	0.1	0.4
Remain in nursing home	63.7	68.1	71.7	73.4	74.2	75.6	76.8	74.2
CHESS = 4								
Died in hospital	4.5	3.4	3.7	2.3	2.4	3.4	1.4	1.9
Died in nursing home	30.1	31.4	31.6	31.2	32.0	29.5	32.3	34.0
Hospitalized (no death)	12.2	10.7	9.3	8.3	8.5	8.4	6.5	2.8
Discharged home	0.6	0.4	0.2	0.2	0.0	0.2	0.0	0.9
Discharged other setting	0.8	0.7	0.6	0.8	0.6	0.3	0.0	0.0
Remain in nursing home	51.8	53.5	54.7	57.2	56.5	58.3	59.8	60.4
CHESS = 5								
Died in hospital	3.0	1.7	1.8	1.9	0.8	2.1	0.0	0.0
Died in nursing home	71.1	77.5	77.0	72.7	78.3	77.8	78.7	81.0
Hospitalized (no death)	4.4	2.7	4.0	4.9	1.6	1.4	2.7	0.0
Discharged home	0.3	0.2	0.0	0.0	0.0	0.0	1.3	0.0
Discharged other setting	0.3	0.5	0.4	0.4	0.8	0.0	0.0	0.0
Remain in nursing home	20.8	17.3	16.9	20.1	18.5	18.8	17.3	19.0

These effects persisted after adjusting for numerous demographic, diagnostic, regional, facility, and clinical covariates.

Why would day of stay be associated with different health outcomes? Survival bias may result in over-representation of more robust residents later in the stay whereas the most frail and vulnerable persons are selected out early on in the stay. However, many frailty-related covariates are controlled for, and the temporal differences apply to both positive and negative outcomes. Alternatively, there may be more acute or malleable conditions (eg, malnutrition related to dementia) early in the stay that are more treatable than persistent conditions that are difficult to treat (eg, heart failure).

Admission to the nursing home may provide an opportunity to stabilize and ameliorate health problems that, when resolved, would allow the person to return home. As a practical consideration, the person may be able to return to a home he or she still owns early in the stay, but return to the community becomes substantially more difficult later in the stay if the home was sold.

Alternatively, the stress associated with relocation to a nursing home may be most pronounced early in the stay and diminish as the person becomes accustomed to the environment. Also, the care of the person may improve over the episode as staff become more familiar with their strengths, preferences, and needs. Staff may become more sensitive to changes that may signal health problems. They may be better able to manage the person's health needs in the home or they may be more cognizant of advance directives affecting transfers to hospital or resuscitation.

No matter the explanation, the first 90 days of a stay are important. Both positive and unwanted changes are most likely to occur early in the episode of care after controlling for a host of other covariates.

So what are the practical implications of that finding? First, we must share and employ clinical assessment information about the person's status at admission to nursing homes. Rapid action is needed to identify newly admitted residents with elevated risks of adverse outcomes. Prior assessments done by home care agencies should be shared with the nursing home for a longitudinal view of the person's health trajectory. Admission assessments must be timely and accurate to best equip staff with the information needed to provide care and engage the person and family members in collaborative care planning. We should manage and reduce stressors that affect the transition to the nursing home. The first 90 days come with the greatest risk of

Table 3
Adjusted Odds Ratios (95%CL) for Transitions to Various States Based on Assessment Period From Multistate Transition Model, Ontario, Alberta, and British Columbia

CHESS Score at baseline (T_1)	Transitions at Follow-Up (T_2)						
	Remained in Nursing Home CHESS Score			Admitted to Hospital	Died	Discharged Other Setting	Discharged Home
	0	1-2	3+				
Odds ratios (95% CL) for first quarter after admission (ref = stays ≥1 y)							
0	–	1.63**** (1.46, 1.82)	1.23**** (1.19, 1.27)	1.48**** (1.43, 1.54)	2.26**** (2.03, 2.51)	2.49**** (2.00, 3.09)	6.21**** (4.86, 7.93)
1-2	1.44**** (1.39, 1.50)	–	1.12*** (1.05, 1.19)	1.63**** (1.57, 1.70)	2.53**** (2.36, 2.70)	3.98**** (3.16, 5.02)	10.10**** (7.20, 14.16)
3+	2.26**** (1.91, 2.68)	1.40**** (1.25, 1.57)	–	1.93**** (1.69, 2.20)	1.54**** (1.36, 1.74)	2.85**** (1.73, 4.71)	4.06**** (2.03, 8.12)
Odds ratios (95% CL) for second quarter after admission (ref = stays ≥1 y)							
0	–	ns	1.20** (1.07, 1.339)	1.25**** (1.20, 1.30)	1.39**** (1.24, 1.56)	1.84**** (1.47, 2.30)	2.78**** (2.15, 3.60)
1-2	1.13**** (1.09, 1.17)	–	ns	1.27**** (1.22, 1.32)	1.50**** (1.39, 1.61)	2.78**** (2.19, 3.53)	4.17**** (2.93, 5.93)
3+	1.23* (1.03, 1.47)	1.152** (1.03, 1.29)	–	1.43**** (1.26, 1.63)	1.52**** (1.344, 1.712)	1.73* (1.03, 2.93)	ns
Odds ratios (95% CL) for third quarter after admission (ref = stays ≥1 y)							
0	–	ns	ns	1.13**** (1.09, 1.18)	1.18** (1.05, 1.33)	ns	1.60*** (1.21, 2.12)
1-2	1.09**** (1.05, 1.13)	–	ns	1.14**** (1.09, 1.19)	1.19**** (1.10, 1.28)	1.84**** (1.43, 2.38)	2.52**** (1.74, 3.66)
3+	ns	ns	–	1.18** (1.04, 1.35)	1.14* (1.00, 1.28)	ns	ns
Odds ratios (95% CL) for fourth quarter after admission (ref = stays ≥1 y)							
0	–	ns	ns	1.09*** (1.04, 1.13)	ns	Ns	ns
1-2	1.07*** (1.03, 1.11)	–	ns	1.06** (1.01, 1.10)	1.15*** (1.06, 1.24)	1.65*** (1.27, 2.15)	1.84** (1.24, 2.74)
3+	ns	ns	–	ns	ns	ns	ns

ADRD, Alzheimer's disease and related dementias; COPD, chronic obstructive pulmonary disease; UTI, urinary tract infection.
Rows represent the starting CHESS state at the time of the baseline assessment and columns reflect the adjusted odds ratios (95% CL) for each follow-up state.
Asterisks indicate the maximum P value for a given estimate: * .05 ** .01 *** .001 **** <.0001.

multiple transitions and they set the stage for the person's experience over the rest of the episode of care. Hence, new admissions to nursing homes should be targeted purposefully for more intensive care to support that transition.

We must also keep options open at least in the earliest parts of the stay. If an individual is going to be discharged back to the community, it is most likely to happen in the first 90–180 days. Family members should be encouraged to maintain options for alternative care approaches should the person's health needs improve after admission.

Our results also show that improvement trajectories, albeit less common than decline, are still possible in long-term care. Death is not the only outcome of interest for nursing homes. Clinical interventions offered in long-term care should include those that promote improvement and maintenance of function and health status.

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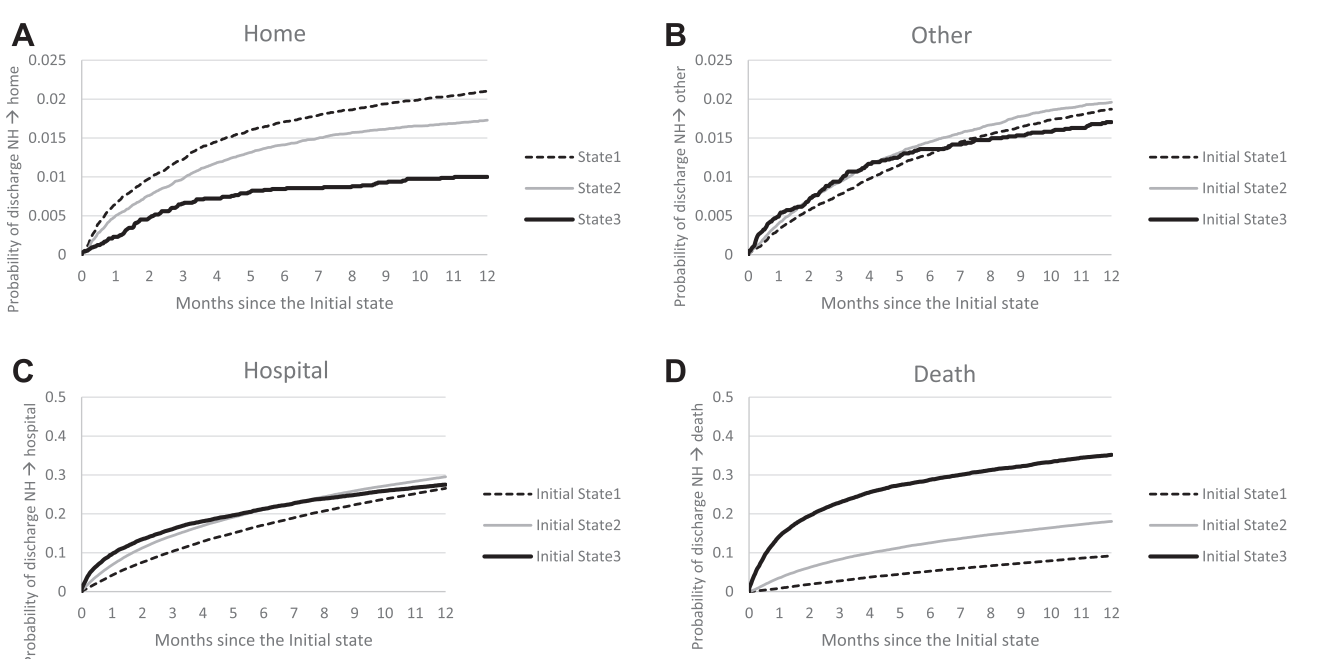

Fig. 2. Cumulative incidence function (CIF) plots for 4 types of transitions 1 year after admission assessment by baseline CHESS score, Ontario, Alberta, and British Columbia.

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Appendix

Supplementary Table 1
Construction of Analytic Data Set for Multistate Models

Steps in Dataset Construction	No. of Individuals	No. of Assessments	No. of Episodes/ Patient Admission
Total LTC (sector code = 4) records in CCRS (linked) file	373,760	3,272,838	530,729
If sex = 'O' then delete	373,424	3,269,890	530,172
Remove if missing scrambled ID number, assessment date or entry date	373,424	3,269,890	530,172
Remove assessments without CHESS	373,351	3,268,212	529,949
If discharge date is missing, then check if there is an assumed discharge date. If there is assumed discharge date, then use assumed discharge date as discharge date. If there is no assumed discharge date, then use data cut-off date March 31, 2015 as censoring date.	373,351	3,268,212	529,949
If clients have discharge disposition without discharge date information, then remove discharge disposition (confirmed with CIHI)	373,351	3,268,212	529,949
If a patient returns to LTC within 14 d from the previous date of discharge, then consider as 1 episode -No. of people who have linked episodes = 85,899 -No. of episodes that are linked = 223,158 episodes -> 103,246 eps	373,351	3,268,212	410,037
Delete episodes if the first assessment is not the initial assessment and delete if the initial assessment is not done within 14 d of entry	225,415	1,619,934	241,129
Delete if q1c (Short stays indicator) = 1, 2, or 3 and discharged within 90 d from the initial assessment.	207,199	1,590,414	213,481
Delete if p1aq (respite indicator) = 1 and discharged within 90 d from the initial assessment.	207,061	1,590,188	213,267
Select only the first episode for each client	207,061	1,555,298	207,061
Delete all assessments where the initial assessment was done before January 1, 2010	172,732	1,160,141	172,732
Delete all assessments where age at the initial assessment was less than age 65 y	163,176	1,088,336	163,176
12 residents' age assessments were not accurate (older than age 65 y in initial assessments but younger than age 65 y in later assessments) Hence, replace age in later assessments with the initial assessment's age (96 assess in total)	163,176	1,088,336	163,176

LTC, long-term care.