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Assessments of heart failure and frailty-related health instability provide complementary and useful information for home care planning and prognosis

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Title: Assessments of heart failure and frailty-related health instability provide complementary and useful information for home care planning and prognosis

Short title: Heart failure transitions in home care

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Brief summary

Heart failure is common among home care recipients, who have a high burden of comorbidity, frailty, and geriatric syndromes. A referral to home care is often a harbinger of health instability, as measured in routine home care assessments. We completed a retrospective study of 286,232 home care clients in Alberta, British Columbia, Ontario, and the Yukon. Heart failure and health instability are both associated with worsening health outcomes, providing complementary information for care planning.

Abstract (246 words)

Background: Health instability, measured with the Changes in Health and End-stage disease Signs and Symptoms (CHESS) scale, predicts hospitalizations and mortality in home care clients. Heart failure (HF) is also common among home care clients. We seek to understand how HF contributes to the odds of death, hospitalization or worsening health among new home care clients depending on admission health instability.

Methods: We undertook a retrospective cohort study of home care clients aged 65 years and older between January 1st 2010 and March 31st 2015 from Alberta, British Columbia, Ontario, and the Yukon, Canada. We used multistate Markov models to derive adjusted odds ratios (OR) for transitions to different health instability states, hospitalization, and death. We examined the role of HF and CHESS at 6 months after home care admission.

Results: The sample included 286,232 clients. Those with HF had greater odds of worsening health instability than those without HF. At low-moderate admission health instability (CHESS 0-2), clients with HF had greater odds of hospitalization and death than those without HF. Clients with HF and high health instability (CHESS $\geq$ 3) had slightly greater odds of hospitalization (OR 1.08, 95% Confidence Interval 1.02-1.13) but similar odds of death (OR 1.024, 95% CI 0.937-1.120) compared to clients without HF.

Conclusions: Among new home care clients, a HF diagnosis predicts death, hospitalization and worsening health, predominantly among those with low-moderate admission health instability. A HF diagnosis and admission CHESS score provide complementary information to support care planning in this population.

Key words: Heart failure, home care, interRAI, hospitalizations, mortality, multistate transitions

Introduction

Population aging, coupled with greater survival of persons with ischemic heart disease, is a prime driving force behind a global heart failure (HF) epidemic affecting millions, and which has become a leading cause of hospitalization, mortality, and health care spending(1, 2). HF in older persons is often complicated by multimorbidity, cognitive impairment, frailty, functional impairment, and other geriatric syndromes (3). Following a hospitalization, as many as 20% of older HF patients may be discharged home with support services, such as home care(4).

Home care generally refers to services, including support for activities of daily living (e.g. bathing, dressing), rehabilitation, and nursing, delivered to persons still able to reside in their own homes and who do not require an institutional setting(4). HF may affect up to 20% of long-stay home care clients, most of whom are over the age of 80 years and affected by a high burden of chronic multimorbidity, cognitive impairment, depressive symptoms, pain, urinary incontinence, falls, and difficulty with basic activities of daily living such as toileting(4-7).

Clients with HF are often admitted to home care after a hospital discharge, or have visited an acute care hospital in the months prior to the initiation of home care services(5-7). In Canada, home care clients are designated long-stay if they receive services for over 60 days(8). Those with HF have an elevated risk of future hospitalization, particularly for cardiovascular causes,

are at increased risk of falls and adverse drug events, and are up to 40% more likely to die than home care clients without HF(6, 7, 9).

Thus, among long-stay home care clients, a HF diagnosis is associated with a greater risk of poor health outcomes related to comorbidities, cognitive impairment, depressed mood, and other geriatric syndromes such as frailty. Admission to home care itself often reflects a transition to a state of increased frailty-related health instability that is also associated with greater odds of hospitalization and death(10). This raises questions about how best to organize the care of these clients, including how the role of cardiovascular specialists might evolve, and whether additional specialized services, such as geriatrics or palliative care, might also have a role. The purpose of this manuscript is to better understand how HF contributes to poor outcomes among newly admitted long-stay home care clients in light of their admission health instability, and describe the associated risks of subsequent transitions to different health states.

Materials and methods

Study Design

We undertook a retrospective cohort study of long-stay home care clients living in the community and receiving publicly administered home care from January 1st 2010 to March 31st 2015 in four Canadian jurisdictions, British Columbia, Alberta, Ontario, and the Yukon. We obtained Research Ethics approval from the University of Waterloo Office of Research Ethics (ORE# 18228) and complied with the Declaration of Helsinki. We followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) and the Reporting of Studies Conducted Using Observational Routinely Collected Health Data (RECORD) guidelines(11, 12).

Data sources

We used linked administrative data sets from the Canadian Institute for Health Information (CIHI): The Home Care Reporting System (HCRS), and the Discharge Abstract Database (DAD) and the National Ambulatory Care Reporting System (NACRS) that track acute hospitalization and emergency department visits, respectively. These data sets were linked using individual clients' unique Provincial health insurance identifiers

The HCRS contains clinical information from the interRAI Resident Assessment Instrument Home Care (RAI-HC), mandated for use in eight Canadian provinces and territories(8, 13). The RAI-HC is a standardized assessment of needs, preferences, and strengths of home care clients. It is completed on all long stay home care clients by trained nurses, on admission and every 6 months thereafter. The instrument contains approximately 300 clinical variables, and supports care planning, outcome measures, quality improvement, and resource allocation(4, 13). The reliability and validity of the RAI-HC and of its embedded scales have been well-established by several international studies, and the sensitivity and specificity of the diagnosis of HF in the RAI-HC are 0.61 and 0.90, respectively, comparable to most administrative data sets(13-19). The reliability of diagnoses and diagnostic codes captured through DAD and NACRS databases have been previously established (20, 21).

Study Cohort

We specified the analytic cohort starting with all RAI-HC assessments for 768,181 individuals with complete discharge information in the HCRS until March 31, 2015 and from British Columbia, Alberta, Ontario, and the Yukon (see Figure 1). These jurisdictions were included because their RAI-HC data collection systems were well-established during that study period(8). We excluded clients first assessed in hospital, long-term care or complex continuing care (n=45,751), whose gender was specified as “other” for privacy reasons due to small cell sizes (n=18), who were living in assisted living or residential care facilities (51,681), and whose initial assessment or age was less than 65 years before the RAI HC assessments were formally mandated in these four jurisdictions on January 1, 2010 (384,408). This left a final cohort of 286,232 patients. A 180-day follow-up period was established for each assessment using subsequent RAI-HC assessments, the RAI-HC discharge tracking form, DAD, and NACRS records. All assessments were kept for longitudinal analysis until the client transitioned out of home care, died, or final available data were reached.

Insert Figure 1 about here

Outcomes of interest

We tracked five types of transitions in the 180-day follow-up: change in health instability, discharge from home care, transfer to other care settings (e.g., assisted living, long-term care home), hospitalization, and death. Health instability was measured with the CHES (Changes in Health and End-stage disease Signs and Symptoms) scale, embedded in the RAI-HC and other interRAI instruments (see Box 1). The CHES scale thus reflects the risk of adverse events related to acutely decompensated frailty, with higher scores shown to predict hospitalization and mortality among home care and long-term care clients, including those with HF(10, 22-25). We ascertained the other outcomes, including death, using HCRS, DAD, and NACRS variables in respective care settings.

Box 1: The interRAI CHES scale: interRAI instruments are completed by trained assessors who make use of all possible sources of information to ascertain the status of a client. The CHES scale is scored from 0 (no health instability) to 5 (very high health instability) based on the following items:

- 1 point for each of recent (within 2 weeks) decline in Activities of Daily Living and Cognitive Performance;
- Up to 2 points for the presence of the following 5 symptoms: insufficient fluid intake, peripheral edema, shortness of breath, vomiting, weight loss, decrease in food eaten;
- 1 point for end-stage disease based on the clinical judgement of a physician that a patient has 6 months or less to live.

Admission characteristics

Using information from the first RAI-HC assessment, we recorded demographic data (age, sex, marital status), scores on Cognitive Performance Scale (CPS), Depression Rating Scale (DRS), Activities of Daily Living, day of stay when first assessed with the RAI-HC, functional improvement potential (self and clinician perceptions), physician visits, facility size, and advanced directives (i.e., Do Not Resuscitate, Do Not Hospitalize)(4, 5, 10, 13, 18, 26-28). We also recorded comorbidities (HF, pneumonia, Chronic Obstructive Pulmonary Disease, diabetes mellitus, renal failure, arthritis, Alzheimer's Disease and Related Dementias - ADRD, depression, cancer) from the RAI-HC, the reliability of each has been previously established(16).

Statistical methods

We used multistate Markov models to examine the odds of transitions in health status over time and identify factors that influence these changes. We have previously used and described these methods elsewhere(10, 23, 29). Figure 2 is a state-space diagram for home care. It includes 7 states defined as 3 possible CHESS states (0, 1-2, 3-5) for clients remaining in home care and 4 discharge destinations (hospital, death, home, or long-term care home). Transitions in time (for example, T1 to T2) towards higher CHESS scores represents rising health instability whereas transition to lower CHESS scores indicates decreasing health instability. Discharge destinations are absorbing states, since transitioning to one of these marks the end of a home care episode. We compared transitions of clients with HF to those without. For inclusion in the analysis, all cases required complete covariate information at home care admission, and 6-monthly assessments until discharge (the 4 absorbing states). To model changes in state, statistical analyses were based on a discrete time nonhomogeneous Markov chain model, as described previously(29).

Insert Figure 2 about here

Results

Our final sample included 286,232 home care clients (Table 1), 17034 (5.95%) from Alberta, 53715 (18.77%) from British Columbia, 215215 (75.19%) from Ontario, and 268 (0.09%) from the Yukon. Mean age was 81.2 (± 7.6) years, 60% were women, and 34,950 (12.2%) had a diagnosis of HF. Compared to clients without HF, those with HF were older (82.7 ± 7.4 vs. 81.0 ± 7.6 years), more likely to be men, and more functionally impaired. Clients without HF were marginally more likely to have cognitive impairment, though the rate of any cognitive impairment in clients with HF was 62.8%. Clients with HF were more likely to have chronic obstructive pulmonary disease and vascular comorbidities, while those without HF had more dementia, cancer, and depression. Long-stay home care clients with HF had greater admission health instability than those without, with over one third having high health instability, as defined by a CHESS score of 3 or higher.

Insert Table 1 about here

Table 2 depicts the proportion of clients who experienced each different health transition or outcome, classified according to admission CHES score and HF diagnosis. The proportion of home care clients who were discharged to another setting decreased with high admission CHES scores. Most clients discharged from home care, without hospitalization, institutionalization, or death, were deemed to have clinically improved and to no longer require home care.

Table 3 depicts odds ratios of different health transitions from the CHES state at the admission home care assessment, to a change in CHES state, death, hospitalization, institutionalization, or discharge to another setting, and comparing clients with HF to those without. Regardless of the admission CHES state, home care clients with HF had higher odds of developing greater health instability over time than those without HF. Clients with HF had higher odds of being hospitalized at all levels of admission health instability. Notably, the relative impact of HF on the odds of hospitalization and death declined with higher admission health instability, with admission CHES scores of 3 or higher being only marginally associated with greater odds of hospitalization but not in the odds of death. In contrast, admission to a long-term care home was less likely among home care clients with HF than those without. Figure 3 depicts total event rates at six months. These were high overall, ranging from 15% for clients with no health instability and no HF, to 60% or higher for clients with a CHES score of 5.

Insert Table 2 about here

Insert Table 3 about here

Insert Figure 3 about here

Discussion

In this retrospective study of newly admitted long-stay home care clients, we demonstrated that a history of HF is associated with greater odds of developing greater health instability, being

hospitalized or dying, and lower odds of improved health and being discharged from home care, particularly among clients with low health instability upon admission to home care. Thus, admission to home care of a client with HF is clearly a harbinger of further decline in health(3). These findings complement those from previous studies in this population and which showed that greater admission health instability, as measured with the interRAI CHESS score, was also associated with worse health outcomes at six months, irrespective of a HF diagnosis.(10)

These findings provide novel information on the prognostic importance of HF relative to frailty-related health instability, with implications on the organization of care for this population. Home care clients often have a high burden of disability, cognitive impairment, depression, and other geriatric syndromes stemming from age-associated comorbidities, but also often from HF itself(3). However, elevated admission health instability in a patient with HF can also reflect the presence of potentially reversible decompensated frailty or comorbidities(10, 22, 23). As HF increases the odds of health deterioration and hospitalization regardless of admission health instability, there clearly remains a need for ongoing involvement of cardiovascular services in the care of these frail home care clients, for whom the benefit of HF management programs has been clearly demonstrated(30, 31). However, optimal care for those with concurrent health instability will require careful coordination with home care and primary care, and potentially involvement of specialized geriatric services or palliative care for those who are most unstable(9, 30, 32-40). Thus, while any home care client with HF could benefit from follow-up in a HF disease management program, an elevated CHESS score of 3 or above in a home care client with HF could trigger an urgent referral to a geriatrician. Our results provide additional support to the importance of capitalizing on a well-established standardized assessment infrastructure, such as the interRAI HC used in home care, to support care planning and system integration for this complex patient population(13, 40-43).

This study has several strengths. First, the longitudinal cohort study design made it easier to establish the existence of an appropriate time sequence. Second, the large sample size allowed for less variability around the estimates and to make more reliable inferences. Third, the use of multistate transition models better accounts for competing risks and better describes client health

trajectories than regression models. A few limitations should be noted. The prevalence of HF in our sample was 12.2% which may be lower than expected from studies of similar high-risk groups(3). The specificity of the HF diagnosis in the interRAI HC is 90%, and thus it is possible that some patients in the control group may also have had HF, albeit possibly with milder or more stable symptoms(16). Moreover, the home care population is defined primarily by functional needs, hence the over-representation in this population of persons with dementia. These results were obtained in a Canadian sample and might not be generalizable to other countries. However, reliable and valid outcomes were assessed, and the findings are robust due to the relevant sample size and to the strength of the associations. Moreover, the RAI-HC instrument has been implemented widely, including in several European countries, and is routinely used in Manitoba, Nova Scotia, Newfoundland and Labrador, and Nova Scotia (currently being implemented in Saskatchewan)(8). The characteristics of home care clients in this study are consistent with those of other studies with patient profiles and health care utilizations similar to Canada(4-9, 44, 45). The data used in this study do not include measures of left ventricular function or information on guideline-directed HF therapies. Under-prescribing of HF therapies has been observed in home care populations and could underlie some of the health instability reflected by CHESS scores(3). While such information would help identify some of the causes of health instability, our findings strongly suggest that a history of HF and health instability should prompt a clinical assessment shortly after admission to home care in order to identify diagnostic and management strategies to stabilize the client's health. Moreover, despite the use of advanced methods, our model likely does not fully capture the nuances of complex care systems. Use of administrative data on hospitalization may have also led to misclassifications of diagnoses or transitions. However, the interRAI covariates in our models reflect direct clinical observations by trained health professionals.

Our data do not allow us to identify the impact of different jurisdictional policies governing the transition of patients from one sector to the next. We have shown previously that such differences exist and have a meaningful impact on the risk of intersectoral transitions, though this work also reiterated the importance of admission health instability on the risk of poor patient outcomes(10). The reasons for the decreased odds of institutionalization into a long-term care

home among home care clients with HF are not clear. These findings may reflect the unpredictable trajectory of HF, which is one of repeated exacerbations followed by a degree of functional recovery, albeit on a background of gradual decline(3). Sudden death or death in hospital during a HF hospitalization is common, and thus relatively fewer home care clients with HF may survive long enough while on the often-lengthy waiting list for a long-term care bed. However, at this time, the mechanisms underling this finding remain unclear.

Conclusions

Among newly admitted home care clients, a history of HF is associated with increased odds of transition to greater health instability and hospitalization, as well as death for those with low-moderate admission health instability. The relative impact of HF is largest when admission health instability, as measured with the CHESS score, is low. A HF diagnosis and CHESS scores thus provide complementary prognostic information in this population. In home care clients, a diagnosis of HF and admission health instability, as measured with standardized assessments used routinely in most Canadian jurisdictions, can support better care planning for this population, which not only includes optimal HF care, but also better integration and targeting of primary care, geriatric services, and palliative care interventions.

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Table 1. Demographic and clinical characteristics (%) of persons with heart failure and without heart failure in home care (British Columbia, Alberta, Ontario, and the Yukon).

	Home Care		
	No Heart Failure	Heart Failure	p value
N	251,282	34,950	

Age			<.0001
65-74	21.7	15.4	
75-84	42.8	40.2	
85-94	33.0	40.7	
95+	2.5	3.7	
Sex			<.0001
Female	60.8	54.1	
Male	39.2	45.9	
Medication Count			<.0001
None	2.0	0.3	
1 to 5	28.4	10.1	
6 or more	69.6	89.6	
Depression Rating Scale			.3294
0: no symptoms	55.93	56.03	
1-2: mild symptoms	24.85	25.06	
3+: moderate to severe symptoms	19.22	18.91	
CHESS			<.0001
0: no health instability	20.4	10.8	
1-2: mild health instability	60.8	54.0	
3: moderate health instability	14.5	26.7	
4: high health instability	4.0	7.8	
5: severe health instability	0.3	0.7	
Cognitive Performance Scale			<.0001
0: no impairment	36.0	37.2	
1-2: mild impairment	52.4	54.6	
3+: moderate to severe impairment	11.6	8.2	
Activities of Daily Living Hierarchy			<.0001
0: independent	62.6	58.4	
1-2: mild dependence	26.8	29.5	
3+: moderate to extensive dependence	10.7	12.1	
Comorbidities			

Chronic obstructive pulmonary disease	15.7	29.7	<.0001
Diabetes	24.3	33.4	<.0001
Alzheimer's disease and related dementias	25.4	17.1	<.0001
Cancer	16.6	12.0	<.0001
Depression	12.7	10.8	<.0001
Coronary artery disease	20.3	40.7	<.0001
Hypertension	58.8	68.6	<.0001
Cardiac dysrhythmia	10.8	28.8	<.0001
Peripheral Vascular Disease	5.1	11.7	<.0001

Table 2: Proportion of long stay home care clients experiencing death, hospitalization, institutionalization into a long-term care homes, or discharged from home care, at 6 months, stratified according to admission heart failure diagnosis and CHESS score.

Outcomes		Total number of clients	Client discharged from Home Care							
			Died (%)	Hospital (%)	LTC (%)	Other settings (%)				
Admission CHESS	H F					No longer requires home care	No longer eligible or referred to other health service	Withdrawn from home care or moved out of area	Cannot contact client / no discharge information	Other
0	No	51262	1.19	16.47	2.12	20.55	2.07	3.55	2.25	0.58
	Yes	3775	1.75	23.80	1.14	14.25	1.67	2.38	2.40	0.57
1,2	No	15279	1.76	20.53	4.52	17.60	1.80	3.31	1.76	1.09
	Yes	18873	2.39	29.08	2.98	11.97	1.49	2.24	1.67	1.10
3+	No	47241	5.45	30.63	6.28	11.22	1.39	2.27	1.61	1.87
	Yes	12302	5.23	36.33	4.34	8.53	1.13	1.56	1.54	2.31

Table 3. Adjusted Odds Ratios (95% CI)¹ of Transition from CHESS state in home care at admission to other CHESS state (if stayed in home care), death, hospital, other setting² or home at 6-month follow-up, according to admission heart failure diagnosis and CHESS score.

Transitions at follow-up (T ₂)								
		Remained in Home Care			Discharge Disposition			
		CHESS Score			Died	Hospital	Long Term Care Home	Other settings
		0	1-2	3+				
Effect of Heart Failure on Health Transitions of Home Care clients (ref=No Heart Failure)								
CHESS Score at admission (T ₁)	0	--	1.21 (1.12- 1.30)	1.78 (1.55- 2.03)	1.58 (1.29- 1.94)	1.47 (1.36- 1.58)	0.976 (0.902- 1.056)	0.77 (0.61- 0.98)
	1-	0.73	--	1.35	1.36	1.34	0.86	0.91
	2	(0.69- 0.77)		(1.29- 1.42)	(1.24- 1.48)	(1.29- 1.38)	(0.82-0.89)	(0.84- 0.98)
	3+	0.61 (0.54- 0.70)	0.84 (0.80- 0.89)	--	1.024 (0.937- 1.120)	1.08 (1.02- 1.13)	0.80 (0.76-0.85)	0.74 (0.68- 0.81)

¹Multi-state transition models adjusted for: home nursing visits, age, gender, marital status, ADL Hierarchy scale score, Cognitive Performance Scale score, comorbidities (binary variables for COPD, pneumonia, diabetes, arthritis, renal failure, UTI, ADRD, cancer, depression), functional improvement potential, jurisdiction.

²See Table 2 for description of other settings.

Figure 1. Derivation of the analytical cohort.

Figure 2. State-space diagram for possible transitions from home care in multistate Markov model.

Figure 3. Proportion of home care clients who were admitted to a long term care (LTC) home, died (at home or in hospital), were admitted to hospital but did not die there within 6 months of intake assessment, by CHESS score and Heart Failure, British Columbia, Alberta, Ontario, and the Yukon.

Figure 1: Derivation of the analytical cohort.

Figure 2. State-space diagram for possible transitions from home care in multistate Markov model.

Note: Dashed lines reflect transitions between health states for those remaining in home care. Solid lines reflect transitions to “absorbing states” outside of the home care.

Figure 3. Proportion of home care clients who were admitted to a long term care (LTC) home, died (at home or in hospital), were admitted to hospital but did not die there within 6 months of intake assessment, by CHES score and Heart Failure, British Columbia, Alberta, Ontario, and the Yukon.