

# Research Notes / Notes de recherche

## Rules to Identify Persons with Frailty in Administrative Health Databases\*

Robin Urquhart,<sup>1,2</sup> Anik M.C. Giguere,<sup>3,4</sup> Beverley Lawson,<sup>5</sup> Cynthia Kendell,<sup>1</sup> Jayna M. Holroyd-Leduc,<sup>6</sup> Joseph H. Puyat,<sup>7</sup> Arminee Kazanjian,<sup>7</sup> Sharon Straus,<sup>8,9</sup> and Grace M. Johnston<sup>10</sup>

### ABSTRACT

This study sought to develop frailty “identification rules” using population-based health administrative data that can be readily applied across jurisdictions for living and deceased persons. Three frailty identification rules were developed based on accepted definitions of frailty, markers of service utilization, and expert consultation, and were limited to variables within two common population-based administrative health databases: hospital discharge abstracts and physician claims data. These rules were used to identify persons with frailty from both decedent and living populations across five Canadian provinces. Participants included persons who had died and were aged 66 years or older at the time of death (British Columbia, Alberta, Ontario, Quebec, and Nova Scotia) and living persons 65 years or older (British Columbia, Alberta, Ontario, and Quebec). Descriptive statistics were computed for persons identified using each rule. The proportion of persons identified as frail ranged from 58.2-78.1 per cent (decedents) and 5.1-14.7 per cent (living persons).

### RÉSUMÉ

Cette étude avait pour objectif le développement de règles d'identification de la fragilité par l'utilisation de données administratives populationnelles sur la santé qui peuvent être appliquées dans différentes juridictions, en lien avec les personnes vivantes ou décédées. Trois règles d'identification de la fragilité ont été élaborées sur la base de définitions reconnues pour la fragilité, de marqueurs associés à l'utilisation de services, de la consultation d'experts. Ces règles ont été limitées aux variables retrouvées dans deux bases de données administratives communes en santé démographiques : les registres de congé des hôpitaux et les données sur les réclamations des médecins. Ces règles ont été utilisées pour identifier les personnes avec fragilité, qu'elles soient décédées ou en vie, dans cinq provinces canadiennes. Les données des participants provenaient de personnes décédées à l'âge de 66 ans ou plus (provinces : Colombie-Britannique, Alberta, Ontario, Québec, Nouvelle-Écosse) et de personnes vivantes âgées de 65 ans ou plus (provinces : Colombie-Britannique, Alberta, Ontario, Québec). Des statistiques descriptives ont été calculées pour ces personnes en utilisant chacune des règles. La proportion de personnes identifiées comme frêles se situait entre 58,2 et 78,1 % chez les personnes décédées, et entre 5,1 à 14,7 % chez les personnes en vie.

<sup>1</sup> Department of Surgery, Dalhousie University

<sup>2</sup> Department of Community Health and Epidemiology, Dalhousie University

<sup>3</sup> Office of Education and Continuing Professional Development, Department of Family and Emergency Medicine, Pavillon Ferdinand-Vandry, Laval University

<sup>4</sup> Quebec Research Centre for Excellence in Aging, Research Centre of the CHU de Quebec, St. Sacrement Hospital

<sup>5</sup> Department of Family Medicine, Dalhousie University

<sup>6</sup> Departments of Medicine and Community Health Sciences, University of Calgary

<sup>7</sup> School of Population and Public Health, University of British Columbia

<sup>8</sup> Li Ka Shing Knowledge Institute, St. Michael's Hospital

<sup>9</sup> Department of Medicine, University of Toronto

<sup>10</sup> School of Health Administration, Dalhousie University

\* We gratefully acknowledge Sharon Zhang, Jim Si, Refik Saskin, Alejandro Gonzalez, and Louis Rochette for carrying out the analyses in Alberta, Ontario, and Quebec, and Sonia Jean, Serge Dumont, André Tourigny, and René Verreault for their valuable input on this study. This work was supported by the Canadian Frailty Network of the Networks of Centres of Excellence. The funder had no role in the design, methods, data collection, analysis, or preparation of this article.

Manuscript received: / manuscrit reçu : 30/08/16

Manuscript accepted: / manuscrit accepté : 26/05/17

**Keywords:** aging, frailty, identification, algorithm, administrative health data

**Mots clés :** vieillissement, fragilité, identification, algorithme, données administratives sur la santé

Correspondence and requests for reprints should be sent to / La correspondance et les demandes de tirés à part doivent être adressées à :

Robin Urquhart, Ph.D.  
Room 8-032, Centennial Building  
QEII Health Sciences Centre  
1276 South Park Street  
Halifax, NS B3H 2Y9  
<robin.urquhart@nshealth.ca>

## Background

As the world's population rapidly ages, marked by striking increases in the proportion of older people and in their life expectancy (World Health Organization, 2011), more persons will experience frailty than ever before. A recent systematic review found that 10.7 per cent of community-dwelling persons aged 65 years and older experience frailty, although the reported prevalence varied greatly across studies (4.0–59.1%) (Collard, Boter, Schoevers, & Oude Voshaar, 2012). Although there is no single agreed-upon definition of frailty, most describe a syndrome characterized by decreased physiological reserve and reduced ability to respond to stressors (such as acute illness), and thus subject to an increased risk of adverse health outcomes, including death (Fried et al., 2001). Although some researchers characterize frailty in terms of physical attributes (Fried et al., 2001), others incorporate cognitive, psychological, and social elements in frailty definitions and assessments (Gobbens, Luijckx, Wijnen-Sponselee, & Schols, 2010; Rockwood et al., 1999). Despite being more common in older persons and those with multimorbidity, frailty can occur independent of advanced age or specific conditions and disabilities (Fried et al., 2001).

The identification of frailty is a critical step towards improving the care of older persons. At the clinical and patient levels, identification can lead to increased use of interventions (e.g., exercise, reduction of polypharmacy) that reduce the risk of adverse outcomes and optimize quality of life (Sieliwonczyk, Perikis, & Vandewoude, 2014). There are numerous practice-level tools to screen for frailty in clinical practice (Rockwood et al., 2005; Rolfson, Majumdar, Tsuyuki, Tahir, & Rockwood, 2006), although the effectiveness of screening is unknown. At the policy and population levels, identification of persons who are frail may help elucidate the implications and consequences of frailty (e.g., health service use, costs, patient outcomes), identify potential “gaps” in health service organization and delivery, and

design medical and social programs and policies to maximize health and independence as people age.

Several research groups have attempted to identify frail populations using administrative health datasets; these datasets have included a combination of physicians' claims data with information from surveys, institutional continuing care data, and/or home care provision information (Bronskill, Carter, & Costa, 2010; Davidoff et al., 2013; Rosen et al., 2001). Thus, their identification algorithms usually require specific data elements not contained or incomplete within many administrative databases (The John Hopkins University, 2014) or clinical assessment data not routinely available in population-based databases (Bronskill et al., 2010). An example of this, in Canada and internationally, is databases containing InterRAI assessment data that may be used to assess “health instability” via the Changes in Health, End-stage disease, Signs, and Symptoms (CHESS) scale (Hirdes, Frijters, & Teare, 2003), often considered a concept analogous to frailty (Armstrong, Stolee, Hirdes, & Poss, 2010). Although some research groups (Armstrong et al., 2010; Campitelli et al., 2016; Hubbard et al., 2015) have also used InterRAI data from different care settings to measure frailty based on the frailty index (Rockwood & Mitnitski, 2007), this information is not available to the same degree across all Canadian provinces and jurisdictions.

To our knowledge, the only algorithm to identify persons who are frail using common population-based administrative health databases is limited to examining causes of death from death certificate data using diagnostic codes (Fassbender, Fainsinger, Carson, & Finegan, 2009). Although this algorithm may be valuable, frailty is a complex construct wherein the diagnosis of a specific condition is only one of many factors involved. Additionally, this algorithm includes many relatively benign conditions (e.g., acute infections) not indicative of frailty on their own, although which may indicate frailty if a person died from this condition (Fassbender et al., 2009). Consequently, we sought to

develop a more refined frailty “identification rule” using population-based health administrative data that could be readily applied across jurisdictions for living and deceased persons. Given that administrative health databases have the unique potential to provide population-based, unbiased, and efficient measures of quality care (Earle et al., 2003; Iezzoni, 1997), the ability to identify frailty in administrative health databases enables researchers and health system decision-makers to efficiently measure/monitor health care utilization and quality of care for persons with frailty, regardless of where they live or which services they access.

## Methods

This study involved two phases: (1) development of rules and (2) identification using population-based datasets available across Canadian provinces. Ethical approval was granted by the Behavioral Research Ethics Board of the University of British Columbia; Conjoint Health Research Ethics Board of the University of Calgary; St. Michael’s Hospital Research Ethics Board; *Comité d’éthique de la recherche du Centre de santé et de services sociaux de la Veille-Capitale* [Research Ethics Committee of the Health and Social Services Centre – *Veille-Capitale*]; *Comité d’éthique de la recherche du CHU de Québec* [Research Ethics Committee of the Centre hospitalier universitaire de Québec]; and the Nova Scotia (NS) Health Authority Research Ethics Board.

### *Development of Rules*

We drafted preliminary identification rules by consulting literature wherein some form of claims-based data was used (Hoover, Rotermann, Sanmartin, & Bernier, 2013; Kim & Schneeweiss, 2014). We also incorporated definitions of frailty from aging research (Rockwood et al., 2005; Rolfson et al., 2006) and markers of service utilization by persons who are frail, such as long-term care (LTC) residency and multiple hospitalizations. Pertinent literature was identified via (1) an initial search of PubMed; (2) consultation with experts in the field (see next paragraph); and (3) a scoping review (led by co-author AMCG) to identify current health care services and models, use of health care resources, and outcomes of care relevant to older adults with frailty. Relevant articles from the latter were reviewed among our team to help with rule development. We limited rule development to variables within two population-based datasets available across Canadian provinces: hospital discharge abstracts and physician claims data. We intentionally focused on specificity over sensitivity, knowing that some persons who are frail would not be identified by using administrative data. No specific criteria were employed to balance specificity over sensitivity. Rather, this balance was

considered and fine-tuned through iterative team discussions and consultation with experts in geriatric medicine.

We provided the preliminary rules to geriatricians and researchers with expertise in administrative data, gerontology, and/or end of life care ( $n = 11$ ). These experts included six practicing physicians with expertise in geriatric medicine (with 4/6 also experts in frailty research) and five researchers with expertise in administrative health data (with 2/5 also experts in using administrative data for end-of-life care research). Through an iterative process, experts were asked whether they agreed with the rules, whether anything was missing, and how they could be improved based on their individual clinical and/or technical knowledge. Following this consultation, we made adjustments to improve specificity and sensitivity, including the use of diagnoses codes corresponding to conditions and functions described in the Clinical Frailty Scale (Rockwood et al., 2005) and Edmonton Frail Scale (Rolfson et al., 2006); adding a rule for persons receiving palliative care; and limiting the criterion related to number of falls to only falls leading to a hospital admission.

### *Identification in Population-Based Datasets*

The final identification rules were used to identify persons potentially with frailty aged 65 years and older in five participating provinces (British Columbia, Alberta, Ontario, Quebec, Nova Scotia) using two administrative health datasets: the Canadian Institutes of Health Information Discharge Abstract Database (DAD) or Med-Echo in Quebec, and each province’s health insurance database (i.e., physician claims). DAD (Med-Echo in Quebec) includes data related to all hospital discharges in each province (from acute, chronic, and rehabilitation facilities). These databases were linked at the patient level using encrypted health care numbers.

With the exception of Nova Scotia, we identified persons with frailty from two populations: (1) those who had died and were 66 years or older at the time of death (decedents) and (2) living persons 65 years or older (living persons). In Alberta, Ontario, and Quebec, the decedents included all persons with a recorded date of death within fiscal year (FY) 2013–2014. In British Columbia, the decedents included all persons with a recorded date of death between FY 2009–2010 and 2013–2014. In Nova Scotia, the decedents included all persons who died from cancer between FY 2004–2005 and 2008–2009 (an existing linked administrative dataset). In British Columbia, Alberta, Ontario, and Quebec, the living persons were alive throughout FY 2013–2014, which represented the most recent year of administrative health data available at the time of study. The differences across provinces were due to

**Table 1: Identification rules to identify persons with frailty using administrative health data**

<b>Identification Rule #1<sup>a</sup></b>	
<b>1. Person is a long-term care resident</b>	
<b>Database</b> Discharge abstract database (DAD) or Med-Echo in Quebec	<b>Variable name</b> Institution patient was admitted from (e.g., nursing home) Institution where patient was discharged to (e.g., nursing home) Institution type (e.g., nursing home) Discharge (e.g., nursing home)
Physician claims	Location where the service was provided (e.g., nursing home, long-term care facility)
<b>Identification Rule #2<sup>a</sup></b>	
<b>2. Person is receiving palliative care</b>	
<b>Database</b> DAD or Med-Echo	<b>Variable name</b> Main patient service (palliative care) Diagnosis codes related to palliative intent
Physician claims	Physician type (palliative medicine) Diagnosis codes related to palliative intent Location of service (e.g., hospice)
<b>Identification Rule #3<sup>a</sup></b>	
<b>3. Person meets at least TWO or more of the domains from 3a to 3g, which are derived from frailty scales and service utilization</b>	
<b>Database</b> <i>3a. Cognitive impairment</i> DAD or Med-Echo and/or physicians' claims	<b>Diagnosis or Variable name</b> Senile dementia, uncomplicated Dementia in Alzheimer's disease Vascular dementia Dementia in other diseases classified elsewhere Unspecified dementia Cerebral degenerations usually manifest in childhood Other cerebral degenerations including Alzheimer's Senility without mention of psychosis Delirium
<i>3b. General health status [Persons have record of at least one of i to iv below]</i> DAD or Med-Echo	i. At least 2 hospital admissions in past year OR
DAD or Med-Echo and/or physicians' claims	ii. At least 2 ED visits in past year OR
DAD or Med-Echo and/or physicians' claims	iii. Malaise and fatigue / debility OR
<i>3c. Incontinence</i> DAD or Med-Echo and/or physicians' claims	iv. Cachexia  Urinary incontinence Fecal incontinence
<i>3d. Falls</i> DAD or Med-Echo	Falls [only counted if associated with hospitalization]
<i>3e. Nutrition issues [Persons have record of at least one of i to ii below]</i> DAD or Med-Echo and/or physicians' claims	i. Abnormal weight loss; underweight; feeding difficulties; anorexia; other symptoms and signs concerning food and fluid intake OR
DAD or Med-Echo and/or physicians' claims	ii. Failure to thrive (adult)
<i>3f. Functional performance [Persons have record of at least one of i to v below]</i> DAD or Med-Echo and/or physicians' claims	i. Abnormality of gait OR
DAD or Med-Echo and/or physicians' claims	ii. Difficulty in walking OR
DAD or Med-Echo and/or physicians' claims	iii. Muscular wasting and disuse atrophy OR

Continued

**Table 1: Continued**

Identification Rule #3 <sup>a</sup>	
DAD or Med-Echo <i>and/or</i> physicians' claims	iv. Muscular weakness OR
DAD or Med-Echo <i>and/or</i> physicians' claims 3g. Targeted health service utilization [Persons have record of <b>at least one</b> of i to iii below]	v. Pressure ulcer
Physician claims	i. <i>At least one</i> geriatrician billing claim OR
DAD or Med-Echo	ii. <i>At least one</i> geriatrician service claim OR
Physician claims	iii. <i>At least one</i> provider home visit (all types)

<sup>a</sup> Contact the corresponding author for the associated formats and International Classification of Diseases (ICD) 9 and ICD 10 codes.

data availability in each province. All records (encounters) in both databases were examined for the time periods of interest. We calculated descriptive statistics for persons identified using each rule, by province. Cohort identification and analyses were carried out separately in each province using a consistent approach.

**Results**

We developed three identification rules to be used with administrative health data. These are shown in Table 1. In brief, persons with claims data meeting at least

one of the following three rules were considered frail: (1) person was a LTC resident; (2) person received palliative care; or (3) person was categorized as meeting at least two of seven domains, which were based on frailty scales, geriatrician discussions, and health service utilization indicators.

Tables 2 and 3 depict the number and proportion of persons identified as frail, as well as frailty identification by specific rule(s), for both decedents and living persons, respectively. The proportion of persons identified as frail was much higher among decedents than

**Table 2: Frailty identification by specific rule(s) for decedents**

Identification Rule <sup>a</sup>	Identification of Persons with Frailty in Health Records of Decedents									
	Nova Scotia <sup>b</sup> 2004/5–2008/9 n = 9,885		Quebec 2013–2014 n = 47,903		Alberta 2013–2014 n = 16,026		Ontario 2013–2014 n = 72,131		British Columbia 2009/10–2013/14 n = 117,314	
	n	%	n	%	n	%	n	%	n	%
1. Person was long-term care resident	1,485	15.0	11,713	24.5	1,1434	71.3	30,734	42.6	59,095	50.4
2. Person received palliative care	3,798	38.4	7,176	15.0	2,134	13.3	14,837	20.6	22,661	19.3
3. Person met <i>at least 2</i> of the listed domains 3a to 3g	3,431	34.7	17,529	36.6	8,269	51.6	22,044	30.6	38,384	32.7
3a. Cognitive impairment	1,265	12.8	12,332	25.7	4,868	30.4	5,931	8.2	35,209	30.0
3b. General health status	6,743	68.2	33,398	69.7	7,673	47.9	42,851	59.4	58,107	49.5
3c. Incontinence (urinary or fecal)	32	0.3	333	0.7	345	2.2	52	0.1	2,145	1.8
3d. Falls (with hospitalization)	228	2.3	235	0.5	1,292	8.1	4,589	6.4	13,490	11.5
3e. Nutrition issues	299	3.0	703	1.5	522	3.3	245	0.3	2,471	2.1
3f. Functional performance	26	0.3	1,212	2.5	400	2.5	942	1.3	3,947	3.4
3g. Targeted health service utilization	3,636	36.8	13,547	28.3	5,499	34.3	23,522	32.6	22,820	19.5
<b>TOTAL PERSONS IDENTIFIED</b>	<b>6,445</b>	<b>65.2</b>	<b>27,887</b>	<b>58.2</b>	<b>12,518</b>	<b>78.1</b>	<b>49,070</b>	<b>68.0</b>	<b>73,081</b>	<b>62.3</b>
Number (%) of patients identified by each combination of identification rules:										
Rule 1 only	791	12.3	6,099	21.9	3,451	27.6	18,117	36.9	40,819	55.9
Rule 2 only	2,109	32.7	3574	12.8	350	2.8	6,080	12.4	10,804	14.8
Rule 3 only	1,398	21.7	1,0301	36.9	634	5.1	8,666	17.7	2,585	3.5
Rules 1 and 2	114	1.8	685	2.5	448	3.6	2,829	5.8	9,827	13.4
Rules 1 and 3	458	7.1	4,311	15.5	6,299	50.3	7,450	15.2	7,016	9.6
Rules 2 and 3	1,453	22.5	2,299	8.2	100	0.8	3,590	7.3	597	0.8
Rules 1, 2, and 3	122	1.9	618	2.2	1,236	9.9	2,338	4.8	1,433	2.0

<sup>a</sup> Persons with frailty identified by each individual identification rule are not mutually exclusive.

<sup>b</sup> Nova Scotia's dataset included all seniors (aged 66+ years) who had died of cancer between 2004–2009.

**Table 3: Frailty identification by specific rule(s) for living persons**

Identification of Persons with Frailty among Living Persons										
Identification Rule <sup>a</sup>	Nova Scotia <sup>b</sup>		Quebec 2013–2014 <i>n</i> = 1,227,708		Alberta 2013–2014 <i>n</i> = 443,088		Ontario 2013–2014 <i>n</i> = 2,321,786		British Columbia 2013–2014 <i>n</i> = 681,394	
	<i>n</i>	%	<i>n</i>	%	<i>N</i>	%	<i>n</i>	%	<i>n</i>	%
1. Person is long-term care resident			27,256	2.2	53,958	12.2	92,694	4.0	42,801	6.3
2. Person receives palliative care			2,002	0.2	143	0.0	1,415	0.1	613	0.2
3. Person meets at least 2 of the listed domains 3a to 3g			73,671	6.0	40,056	9.0	38,827	1.7	22,012	3.2
3a. Cognitive impairment			81,353	6.6	22,981	5.2	12,410	0.5	30,141	4.4
3b. General health status			219,350	17.9	36,037	8.1	232,870	10.0	75,934	11.1
3c. Incontinence (urinary or fecal)			9,400	0.8	4,329	1.0	288	0.0	3,523	0.5
3d. Falls (with hospitalization)			593	0.0	7,165	1.6	18,221	0.8	8,197	1.2
3e. Nutrition issues			5,581	0.5	1,390	0.3	451	0.0	1,462	0.2
3f. Functional performance			7,341	0.6	2,407	0.5	1,692	0.1	2,917	0.4
3g. Targeted health service utilization			79,796	6.5	20,591	4.6	90,279	3.9	22,968	3.4
<b>TOTAL PERSONS IDENTIFIED</b>			<b>91,045</b>	<b>7.4</b>	<b>64,994</b>	<b>14.7</b>	<b>119,116</b>	<b>5.1</b>	<b>44,880</b>	<b>6.6</b>
Number (%) of patients identified by each combination of identification rules:										
Rule 1 only			15,745	17.3	24,892	38.3	79,248	66.5	39,790	88.7
Rule 2 only			1,571	1.7	<sup>c</sup>	0.0	638	0.5	266	0.6
Rule 3 only			61,942	68.0	11,017	17.0	25,568	21.5	1,807	4.0
Rules 1 and 2			58	0.1	31	0.0	403	0.3	305	0.7
Rules 1 and 3			11,356	12.5	28,942	44.5	12,885	10.8	2,670	5.9
Rules 2 and 3			276	0.3	<sup>c</sup>	0.0	216	0.2	6	0.0
Rules 1, 2, and 3			97	0.1	93	0.1	158	0.1	36	0.1

<sup>a</sup> Persons with frailty identified by each individual identification rule are not mutually exclusive.

<sup>b</sup> Nova Scotia data among living frail persons were not available.

<sup>c</sup> Numbers suppressed due to small cell counts.

living persons. This was consistent across all provinces where data were available for both deceased and living persons. The proportion of persons identified as frail was highest in Alberta (78.1% and 14.7% for decedents and living persons respectively). Otherwise, the proportion of persons identified as frail was similar across provinces, ranging from 58.2 to 68.0 per cent (decedents) and 5.1 to 7.4 per cent (living persons).

**Discussion**

This study developed identification rules using population-based administrative health databases to identify persons who are frail and applied these rules to decedents and living persons across multiple Canadian provinces. Administrative health databases have the unique potential to provide population-based, unbiased, efficient measures of health care utilization and quality care (Earle et al., 2003; Iezzoni, 1997). Such data represent a powerful tool towards understanding the impacts of frailty for all persons and not simply those enrolled in specific programs such as a specialized geriatric medicine service.

Although algorithms exist to identify frail populations, to date, none have exclusively used population-based

administrative health datasets with information before death. We utilized two databases widely used across Canada, with comparable data structures and fields: hospital discharges and physician claims. Given geriatrician feedback, we included diagnostic codes associated with two clinical frailty scales (Rockwood et al., 2005; Rolfson et al., 2006) and a limited number of suggested events (e.g., falls) rather than the diagnostic codes used by Fassbender et al. (2009). Feedback from geriatricians, who are experts in frailty care, indicates that our rules have face validity. Further, we found that 5.1 to 14.7 per cent of living persons are frail, depending on province. This falls within the range reported in the literature, particularly studies using a physical phenotype frailty definition where the prevalence of frail community-dwelling persons age 65 years and older ranged from 4.0 to 17.0 per cent (Collard et al., 2012). Guided by the cumulative deficits model of frailty (Mitnitski, Mogilner, & Rockwood, 2001), Clegg et al. recently developed and validated a frailty index using primary care electronic medical record (EMR) data (Clegg et al., 2016). In two separate validation cohorts, they estimated the prevalence of moderate and severe frailty to be 12 to 16 per cent and 3 to 4 per cent respectively. Our population-based

findings also correspond to these EMR-based estimates from primary care.

The first decision rule in our set of rules identifies persons with frailty based on whether they are an LTC resident. A recent systematic review that identified the prevalence of frailty in nursing homes ranged widely from 19.0 to 75.6 per cent (Kojima, 2015). Thus, this decision rule appears contradictory with the review's findings. Nevertheless, the geriatricians we consulted throughout decision rule development (practicing in four Canadian provinces) felt that the vast majority of LTC residents have a frail health state, and the proportion of LTC residents who are fit would be negligible in the context of population-based identification. It is possible the countries included in the systematic review (Brazil, Spain, Taiwan, Lebanon, Egypt, the Netherlands, and Poland) use LTC differently (i.e., LTC plays a different role in health care or for different cultural reasons) and/or have substantively different admission criteria than in Canada – as a result, the characteristics of those LTC populations may be different from what we typically see in Canada. Two additional issues are notable. One, the two studies in the review that used frailty definitions upon which we largely based our rules (Edmonton Frail Scale, Clinical Frailty Scale) had the highest prevalence of frailty at 74.1 and 75.6 per cent. Two, the pooled estimates of the prevalence of frailty and prefrailty across the nine studies were 52.3 per cent and 40.2 per cent respectively. Thus, it may be that this particular rule (LTC resident) is an indicator of either a frail or a prefrail state.

The second identification rule (receipt of palliative care) was based on the Clinical Frailty Scale, a well-validated instrument for frailty measurement. Specifically, on this 1–9 scale, 8 (Very Severely Frail) and 9 (Terminally Ill) refer to persons approaching the end of life or with a life expectancy of less than six months, who are not otherwise frail. The third rule required an indication of *at least two* of seven domains based on frailty scales, geriatrician discussions, and health service utilization indicators (see Table 1). Most of these domains were based directly on the Edmonton Frail Scale, another valid measure of frailty. The added domains resulted from consultation with the expert group and involved either a geriatrician service claim or a physician home visit. Although these latter two, on their own, might not indicate frailty, our rule was such that two separate domains had to be met for a person to be identified as frail.

This study has several limitations. First, it was beyond the scope of this study to validate the identification rules; this is a logical next step in the development process. Second, we designed the rules to optimize specificity over sensitivity, but because we did not validate the

rules, we cannot estimate the proportion of persons with frailty who were missed/not identified. This focus also means that the rules risked increasing the false positives rate. Third, our approach did not reflect the continuum of frailty as a health state ranging from fitness to frailty. Fourth, administrative health data do not contain all of the attributes that define frailty (e.g., social/living circumstances) or pertinent clinical information (e.g., results of functional assessments). Nonetheless, our findings concur with others' studies, where frailty was defined via frailty indices using clinical or self-reported data (Clegg et al., 2016; Collard et al., 2012).

The application of our identification rules using administrative databases permits assessment of health care utilization, quality of care, and outcomes for persons with frailty regardless of where they live, which programs they are enrolled in, and whether they are alive or deceased. The data fields on which these rules are based are widely available in administrative health databases outside of Canada, making the rules broadly applicable across jurisdictions. Despite limitations, these rules represent an important step forward towards identifying frailty in administrative data; health ministers from Organisation for Economic Co-operation and Development (OECD) countries recently emphasized the need to make better use of such data to measure health system performance to address the needs of our aging populations (OECD, 2017).

Here, we provide a set of rules to identify persons with frailty from common administrative health databases. We encourage other research groups to validate these rules in existing cohorts and/or apply these rules in their administrative datasets to improve them for future application.

## References

- Armstrong, J. J., Stolee, P., Hirdes, J. P., & Poss, J. W. (2010). Examining three frailty conceptualizations in their ability to predict negative outcomes for home-care clients. *Age and Ageing, 39*(6), 755–758.
- Bronskill, S. E., Carter, M. W., & Costa, A. P. (2010). *Aging in Ontario: An ICES Chartbook of Health Service Use by Older Adults - Technical Report*. Toronto, ON: Institute for Clinical Evaluative Sciences.
- Campitelli, M. A., Bronskill, S. E., Hogan, D. B., Diong, C., Amuah, J. E., Gill, S., ... Maxwell, C. J. (2016). The prevalence and health consequences of frailty in a population-based older home care cohort: A comparison of different measures. *BMC Geriatrics, 16*, 133.
- Clegg, A., Bates, C., Young, J., Ryan, R., Nichols, L., Ann Teale, E., ... Marshall, T. (2016). Development and validation of an electronic frailty index using routine primary care electronic health record data. *Age and Ageing, 45*(3), 353–360.

- Collard, R. M., Boter, H., Schoevers, R. A., & Oude Voshaar, R. C. (2012). Prevalence of frailty in community-dwelling older persons: A systematic review. *Journal of the American Geriatrics Society, 60*(8), 1487–1492.
- Davidoff, A. J., Zuckerman, I. H., Pandya, N., Hendrick, F., Ke, X., Hurria, A., ... Edelman, M. J. (2013). A novel approach to improve health status measurement in observational claims-based studies of cancer treatment and outcomes. *Journal of Geriatric Oncology, 4*(2), 157–165.
- Earle, C. C., Park, E. R., Lai, B., Weeks, J. C., Ayanian, J. Z., & Block, S. (2003). Identifying potential indicators of the quality of end-of-life cancer care from administrative data. *Journal of Clinical Oncology, 21*(6), 1133–1138.
- Fassbender, K., Fainsinger, R. L., Carson, M., & Finegan, B. A. (2009). Cost trajectories at the end of life: The Canadian experience. *Journal of Pain and Symptom Management, 38*(1), 75–80.
- Fried, L. P., Tangen, C. M., Walston, J., Newman, A. B., Hirsch, C., Gottdiener, J., ... Cardiovascular Health Study Collaborative Research, G. (2001). Frailty in older adults: evidence for a phenotype. *Journals of Gerontology, Series A: Biological Sciences and Medical Sciences, 56*(3), M146–156.
- Gobbens, R. J., Luijckx, K. G., Wijnen-Sponselee, M. T., & Schols, J. M. (2010). Towards an integral conceptual model of frailty. *Journal of Nutrition, Health & Aging, 14*(3), 175–181.
- Hirdes, J. P., Frijters, D. H., & Teare, G. F. (2003). The MDS-CHESS scale: A new measure to predict mortality in institutionalized older people. *Journal of the American Geriatrics Society, 51*(1), 96–100.
- Hoover, M., Rotermann, M., Sanmartin, C., & Bernier, J. (2013). Validation of an index to estimate the prevalence of frailty among community-dwelling seniors. *Health Reports, 24*(9), 10–17.
- Hubbard, R. E., Peel, N. M., Samanta, M., Gray, L. C., Fries, B. E., Mitnitski, A., & Rockwood, K. (2015). Derivation of a frailty index from the interRAI acute care instrument. *BMC Geriatrics, 15*, 27.
- Iezzoni, L. I. (1997). Assessing quality using administrative data. *Annals of Internal Medicine, 127*(8 Part 2), 666–674.
- Kim, D. H., & Schneeweiss, S. (2014). Measuring frailty using claims data for pharmacoepidemiologic studies of mortality in older adults: Evidence and recommendations. *Pharmacoepidemiology and Drug Safety, 23*(9), 891–901.
- Kojima, G. (2015). Prevalence of frailty in nursing homes: A systematic review and meta-analysis. *Journal of the American Medical Directors Association, 16*(11), 940–945.
- Mitnitski, A. B., Mogilner, A. J., & Rockwood, K. (2001). Accumulation of deficits as a proxy measure of aging. *The Scientific World Journal, 1*, 323–336.
- Organisation for Economic Co-operation and Development (OECD). (2017). *The Next Generation of Health Reforms: OECD Health Ministerial Meeting*. Paris, FRA: Author.
- Rockwood, K., & Mitnitski, A. (2007). Frailty in relation to the accumulation of deficits. *Journals of Gerontology, Series A: Biological Sciences and Medical Sciences, 62*(7), 722–727.
- Rockwood, K., Song, X., MacKnight, C., Bergman, H., Hogan, D. B., McDowell, I., & Mitnitski, A. (2005). A global clinical measure of fitness and frailty in elderly people. *Canadian Medical Association Journal, 173*(5), 489–495.
- Rockwood, K., Stadnyk, K., MacKnight, C., McDowell, I., Hebert, R., & Hogan, D. B. (1999). A brief clinical instrument to classify frailty in elderly people. *Lancet, 353*(9148), 205–206.
- Rolfson, D. B., Majumdar, S. R., Tsuyuki, R. T., Tahir, A., & Rockwood, K. (2006). Validity and reliability of the Edmonton Frail Scale. *Age and Ageing, 35*(5), 526–529.
- Rosen, A., Wu, J., Chang, B. H., Berlowitz, D., Rakovski, C., Ash, A., & Moskowitz, M. (2001). Risk adjustment for measuring health outcomes: An application in VA long-term care. *American Journal of Medical Quality, 16*(4), 118–127.
- Sieliwonczyk, E., Perkisas, S., & Vandewoude, M. (2014). Frailty indexes, screening instruments and their application in Belgian primary care. *Acta Clinica Belgica, 69*(4), 233–239.
- The John Hopkins University. (2014). *The Johns Hopkins ACG® System – Excerpt from Version 11.0 Technical Reference Guide*. Available at [https://www.healthpartners.com/ucm/groups/public/@hp/@public/documents/documents/cntrb\\_035024.pdf](https://www.healthpartners.com/ucm/groups/public/@hp/@public/documents/documents/cntrb_035024.pdf)
- World Health Organization. (2011). *Global health and aging*. Washington, DC: National Institute on Aging, National Institutes of Health.