BMJ Open

Using frailty and quality of life measures in clinical care of the elderly in Canada to predict death, nursing home transfer and hospitalisation - the frailty and ageing cohort study

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To cite: Rosenberg T, Montgomery P, Hay V, *et al*. Using frailty and quality of life measures in clinical care of the elderly in Canada to predict death, nursing home transfer and hospitalisation - the frailty and ageing cohort study. *BMJ Open* 2019;**9**:e032712. doi:10.1136/bmjopen-2019-032712

► Prepublication history and additional material for this paper are available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2019-032712).

Received 02 July 2019
Revised 07 October 2019
Accepted 18 October 2019

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ABSTRACT

Objective To assess the value of using frailty measures in primary care for predicting death, nursing home transfer (NHT) and hospital admission.

Design Cohort study.

Setting and participants All 380 people, mean age 88.4, living in the community and receiving home-based primary geriatric care from one practice in Victoria, Canada.

Interventions/measurements A 60 min baseline assessment which included: Clinical Frailty Scale (CFS), EuroQol EQ-5D-5L (EQ-5D), EuroQol Visual Analogue Scale (EQ-VAS) and Gait Speed (Gaitspeed).

Outcomes Death, NHT and hospital admission.

Results During 18 months of follow-up, there were 39 (10.3%) deaths, 48 (12.6%) NHTs and 93 (24.5%) individuals admitted to hospital. All three outcomes were predicted by: CFS Level 6+7/4+5 (HR death 5.92, 95% CI 3.12 to 11.22, NHT 6.00, 95% CI 3.37 to 10.66 and hospital admission 2.92, 95% CI 1.93 to 4.40); EQ-5D Quintile 1/Quintile 5 (death 6.26, 95% CI 2.11 to 18.62; NHT 3.18, 95% CI 1.29 to 7.82 and hospital admission 2.94, 95% CI 1.47 to 5.87); EQ-VAS Q1/Q5 (death 7.0, 95% CI 2.34 to 20.93; NHT 3.38, 95% CI 1.22 to 9.35 and hospital admission 6.69, 95% CI 3.20 to 13.99) and Gaitspeed (death 5.87, 95% CI 1.78 to 19.34; NHT 8.51, 95% CI 3.18 to 22.79 and hospital admission 11.05, 95% CI 5.45 to 22.40). Medical diagnoses, multiple comorbidities and polypharmacy were weaker predictors of these outcomes. Cox regression analyses showed CFS (adjusted HR 2.88, 95% CI 1.23 to 6.68), EQ-VAS (0.96, 95% CI 0.93 to 0.98), estimated glomerular filtration rate (0.97, 95% CI 0.95 to 1.00) and haemoglobin (0.97, 95% CI 0.94 to 0.99) were independently associated with death. Gaitspeed (0.13, 95% CI 0.03 to 0.57), Geriatric Depression Scale (1.39, 95% CI 1.07 to 1.82) and dementia diagnosis (4.61, 95% CI 1.86 to 11.44) were associated with NHT. Only CFS (1.75, 95% CI 1.21 to 2.51) and EQ-VAS (0.98, 95% CI 0.96 to 0.99) were associated with hospital admission. No other diagnoses, polypharmacy nor multiple comorbidities predicted these outcomes.

Conclusions For elderly people, standardised simple measures of frailty and health status were stronger predictors of death, NHT and hospital admission than medical diagnoses. Consideration should be given to adding these measures into usual medical care for this age group.

Strengths and limitations of this study

- The Frailty and Ageing Cohort Study (FACTS) is a pragmatic study that embedded valid, reliable and responsive measures of health status and frailty into usual care for a community based elderly population to determine risk for death, nursing home transfer and hospital admission and for planning and evaluation.
- The baseline assessment was found valuable by patients and caregivers and can be administered in <60 min by a trained member of an interdisciplinary team.
- We had a high response rate and 100% follow-up of important longitudinal outcomes.
- Baseline measurement was performed by nurses involved in patient care, but outcomes were objective and measured independently.
- These findings may not be generalisable to a non-frail elderly population or people living in nursing homes.

INTRODUCTION

The elderly population are the highest users of hospital[1] and nursing home care[2] for all adult age groups. However, they are not a homogeneous population with some being frail. Two main models of frailty have been described.[3] The Frailty Phenotype model has been characterised by unintentional weight loss, reduced muscle mass and strength, reduced gait speed, fatigue and low energy expenditure. The second model of frailty is the Cumulative Deficit model which characterises frailty as a cumulation of deficits caused by diseases, injuries and ageing. Both models describe a frailty syndrome characterised by loss of homeostatic reserve and increased vulnerability to adverse outcomes after seemingly minor illnesses, injuries or changes in medication. The frail elderly group are at highest risk for death[4] as well as

a variety of conditions that may compromise their quality of life,[5] lead to hospital admission (HA),[6] loss of independence[7] and nursing home transfer (NHT).[8] The prevalence of frailty is estimated to be 14% for ages >65, 30% for ages 80 to 90 and up to 50% for ages >90.[4 9–12] Despite the increasing burden of frailty in ageing populations, there has been difficulty targeting this group in primary care.[12 13] It can be challenging to objectively distinguish the frail group from well elderly people and quantify their level of risk. Despite the availability of several well validated tools,[14–16] few measures of frailty are used in routine medical care.[12] The health risks for this population are usually poorly estimated from the presence and severity of chronic medical diagnoses alone.[17 18]

The Frailty and Ageing Cohort Study (FACTS) was initiated to improve medical care for the elderly by introducing valid, reliable and responsive frailty and health status measures into usual primary care. We hypothesised that in addition to improving care, these health status measures would be better predictors of death, NHT and HA than medical diagnoses. We chose measures that would be: (1) easy to administer, (2) clinically useful for individual patient care and (3) useful for evaluating interventions at a programme level. A pilot study approved by the University of British Columbia was done in 2015 with 57 elderly people living in the community. We tested a battery of physical, mental and quality of life measures selected from the literature. We found that: (1) the assessment could be done in under 60 min by a trained nurse, (2) the shorter 3-metre gait speed test was as precise, valid and reliable in a home setting compared with the 4-metre test[19] and (3) testing was acceptable to elderly people with 89% reporting it relevant to their health and that they would be prepared to repeat it.

In May 2017 we began administering the FACTS assessment to all the people in our primary-care geriatric practice. This study reports on predictors of death, NHT and hospitalisation after the first 18 months of follow-up.

METHODS

Setting/participants

We included all 380 elderly people, living in the community and receiving home-based primary care from one interdisciplinary geriatric medical practice in Victoria, Canada, between 1 May, 2017, and 30 October, 2018. The description of this practice and outcomes from this model of care have previously been reported.[20] Eligibility criteria to enter this practice include: (1) age ≥70, (2) difficulty accessing office-based care, (3) presence of a frailty syndrome (eg, dementia, falls and chronic pain) and/or (4) multiple comorbidities and need for complex interdisciplinary medical care.

Measurements

Our practice nurses performed the FACTS assessments in people's homes. This assessment included:

Frailty and health status measures

General frailty was measured with the Clinical Frailty Scale (CFS)[14] using the following criteria for levels: Level ≤3- well+/-asymptomatic chronic disease, Level 4 - chronic symptoms or slowed down, Level 5 - dependent in any instrumental activity of daily living (IADL), Level 6 - dependent in at least one basic activity of daily living (BADL) or requiring assistance with stairs and Level 7 - complete dependency in IADL and BADL. The EuroQol EQ-5D-5L Summary Index (EQ-5D) (https://euroqol.org/), administered by interview, was used to measure health-related quality of life (HRQoL) using Canadian norms.[21] The EQ-5D uses a time-trade-off method to establish population norms about how people value their health. Scores range from negative 0.148 (health state worse than death) to 0.949 (their best possible health state). The EuroQol 100-point vertical Visual Analogue Scale (EQ-VAS) was used to measure self-reported health. It is rated from 0 - 'The worst health you can imagine' to 100 - 'the best health you can imagine'.

Cognitive impairment was measured with the Montreal Cognitive Assessment (MoCA) (https://www.mocatest.org/). Depression was assessed with the 5-point Geriatric Depression Scale (GDS).[22–24] The Mini-Nutritional Assessment Short Form (MNA-SF),[18 25–28] Nestlé (https://www.mna-elderly.com/) was used to assess nutritional risk. Because of the high prevalence of oedema, only body mass index and not calf circumference was used for the MNA-SF. The 3-metre gait speed[29–31] (Gaitspeed) was performed with people's usual walking aid and asking them to walk at a comfortable pace. Gaitspeed was measured from the average of the second and third tests and reported in metres/second (m/s). Grip strength[10 32–34] (Gripstrength) in kg was measured with a Jamar Dynamometer using the dominant or stronger hand with the patient sitting with their feet on the floor. The average of three trials was used. The 3-oz water swallow test[35–41] (WST) was used to assess dysphagia and risk for aspiration. Failure was either: inability to drink it all without stopping, coughing while drinking or a wet voice when finished. Sitting and standing blood pressure (BP) were measured with a sphygmomanometer and the difference was recorded. Electronic forms were created for all the tests for use with our OSCAR electronic medical record (EMR) - https://oscar-emr.com/. The EQ-VAS was tested with a marker on a laminated sheet and MoCA trail-making, cube and clock test were done on paper and scanned into the chart. All questionnaires were done by interview.

Demographics, medications, laboratory values, medical diagnoses

Demographics, medications, laboratory values and medical diagnoses were abstracted from the EMR. The medical diagnoses were manually audited and abstracted from a medical history text box that is part of the EMR. The drugs and laboratory values are entered into the database as discrete variables and were queried from the database using the subjects' unique personal identifiers.

Drugs included: all prescription drugs, prescription eye drops, daily acetaminophen or non-steroidal anti-inflammatory drug and prescription vitamins (eg, folic acid or vitamin B12). We did not include calcium, vitamin D, laxatives or other over-the-counter drugs, vitamins or supplements. The list of diagnoses in the EMR were used to classify serious symptomatic medical conditions: (1) Neurological - any of Parkinsonism, neurodegenerative diseases (excluding dementia from this category), stroke/transient ischaemic attack and peripheral neuropathy; (2) Respiratory - any of chronic obstructive pulmonary disease/asthma, interstitial lung disease, pulmonary embolus with chronic dyspnoea; (3) Cardiac - any of ischaemic heart disease, congestive heart failure, atrial fibrillation/flutter, pacemaker, valvular heart disease; (4) Hypertension on treatment; (5) Osteoporotic fracture of either hip, vertebra, forearm, humerus or ribs; (6) Cancer - active excluding non-melanoma skin malignancy; (7) Osteoarthritis or other chronic pain syndrome on regular analgesia; (8) Dementia - Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition criteria and (9) Mood Disorder - including either depression, bipolar disorder or chronic generalised anxiety on medication. Laboratory tests included: estimated glomerular filtration rate (eGFR) in mL/min/1.73 m^2, haemoglobin (Hgb) in g/dL and haemoglobin A1c (HgbA1c) in %. Multiple comorbidities[42] was defined as having three or more of the listed disease systems previously described and including Stages 3B to 5 chronic kidney disease or diabetes (HgbA1c >6.9). We took a 10% random sample of all the charts to examine the reliability of the initial audit of the medical history. The second auditor (PM), who was not involved in patient care, was blinded to the results from the main audit that was used for the data analyses (TR) . There was a 2.3% discrepancy between the two auditors.

Outcomes

All charts were audited by electronic query of the EMR for dates of discharge from the practice, death and NHT. NHTs in Canada are permanent moves for frail people requiring long-term residential complex care. All the charts for people in the study were manually reviewed for accuracy of discharge status and dates of discharge. There is one electronic hospital record for the greater Victoria area which was manually audited for hospital admissions. The number of persons with any admission over the time period was recorded. The nurses who did the assessment were not involved in collecting data on outcomes. The auditors (TR and RL) could access the results of the frailty assessments. However, the outcomes were categorical and the result of a query form the EMR.

Statistics

Means and SD were measured and medians were used if data was not normally distributed. Two-sided t-tests were used for continuous data and X^2 tests with Yates correction for categorical data. Fisher exact test was used if there were less than six observations in one cell.

Data was censored for the duration of observation. Continuous variables were broken into quintiles to calculate HRs for death, NHT and HA. Quintile 1 (Q1) and Quintile 5 (Q5) were compared for HRs, except for Grip-strength which was broken into quartiles because of the smaller numbers for each sex. Kaplan-Meier curves and HRs with 95% CI were tested with the log-rank test for statistical significance.

Cox proportional hazards stepwise regression was used for multivariate analysis. The CFS was strongly associated with each outcome, so other variables that were significant on univariate analysis were added to a two-variable model with CFS. Each of the variables that were significant in the two-variable model were then added into an overall model. All the frailty test measures, age, number of drugs, eGFR and Hgb were entered as continuous variables and WST, diagnostic categories and sex were entered as categorical variables. The final models were adjusted for age, sex, presence of multiple comorbidities and number of drugs. Statistical significance for p values was set at <0.05. Subjects with incomplete data were included in the analyses. Statistical analyses were done with Number Cruncher Statistical System V.10.

An average of 14.1% of people declined to have all or part of the FACTS assessment done (table 1). We had 100% assessment for the three main outcomes as well CFS scores. Because there was minor variability in response rates to individual questionnaires, we coded subjects as non-respondents if they were missing the EQ-5D score. There were 53 (13.9%) non-respondents and 327 (86.1%) with complete data. Online supplementary table 1 compares respondents to non-respondents for key baseline characteristics and outcomes to estimate the effect of response bias. To further test for response-rate bias, missing data was mapped to the CFS score and the average EQ-5D and Gaitspeed Quintiles for each CFS level was imputed for the missing data (online supplementary table 2).

Patient and public involvement

There were no patients involved in the planning and development of the research study. Patients participating in the pilot study were surveyed about the burden and relevance of the FACTS assessment. All patients in the practice were sent a summary of the pilot study results in 2016. Patients and caregivers are advised of the results of their personal FACTS assessment as part of care-planning.

RESULTS

All 380 people in the practice between 1 May, 2017, and 31 October, 2019, were included in the analysis. Table 1 shows the test administration rates, demographics and health status measures for the population. The average test administration rate was 85.9% (range: 80% to 100%) for the nine main health status measures. The mean

Table 1 Baseline characteristics

Variable	Results	No. (%) tested
Age mean (SD)	88.4 (6.5)	380 (100)
Female No. (%)	275 (72.4)	380 (100)
Marital status No. (%)		372 (97.9)
Widowed	221 (59.4)	
Married	108 (29)	
Divorced	31 (3.2)	
Never married	12 (3.2)	
Housing No. (%)		372 (97.9)
House/apartment	219 (58.8)	
Retirement home	110 (29.6)	
Assisted living	43 (11.6)	
Clinical frailty scale mean (SD)	5.6 (0.8)	380 (100)
<4 No. (%)	5 (1.3)	
4 No. (%)	33 (8.7)	
5 No. (%)	112 (29.5)	
6 No. (%)	192 (50.5)	
7 No. (%)	38 (10)	
EuroQol EQ-5D-5L mean (SD)	0.72 (0.18)	327 (86.1)
EuroQol visual analogue scale mean (SD)	71.5 (18.7)	321 (84.5)
Montreal cognitive assessment mean (SD)	20.6 (6.4)	321 (84.5)
5-point geriatric depression scale mean (SD)	1.3 (1.3)	329 (86.6)
Gait speed metres/second mean (SD)	0.59 (0.30)	326 (85.8)
Grip strength kg. mean (SD) - males	23.2 (9.0)	84 (80.0)
Grip strength kg. mean (SD) - females	13.6 (16.6)	231 (84.0)
Water swallow test – failed No. (%)	67 (21.8)	307 (80.8)
Mini-nutritional assessment short form mean (SD)	11.8 (2.1)	308 (81.1)
Systolic BP mm hg mean (SD)	134.6 (15.9)	324 (85.3)
Diastolic BP mm hg mean (SD)	68.7 (8.8)	324 (85.3)
Orthostatic drop SBP >20 mm hg - sit to stand No. (%)	22 (7.1)	308 (81.1)
Haemoglobin <110 No. (%)	44 (11.9)	370 (97.4)
Estimated glomerular filtration rate mL/min/1.73 m^2 mean (SD)	57.4 (19.9)	375 (98.7)
Haemoglobin A1c >6.9% No. (%)	27 (8.9)	304 (80.0)
Diseases No. (%)		380 (100)
Neurological	222 (58.4)	
Respiratory	96 (25.3)	
Cardiac	248 (65.3)	
Cancer	47 (12.9)	
Osteoporotic fracture	141 (37.1)	
Osteoarthritis/chronic pain	226 (59.5)	
Dementia diagnosis	140 (36.8)	
Mood disorder	187 (49.2)	
Multiple (>2) comorbidities No. (%)	324 (85.3)	380 (100)
Number of Drugs mean (SD)	6.0 (3.2)	359 (94.5)

BP, blood pressure; SBP, systolic blood pressure.

(SD) age of the population was 88.4 (6.5), 72.4% were female and 41.2% lived in supportive housing. The mean CFS score was 5.6 (0.8) with 60.5% being levels 6 to 7 (requiring assistance in BADL). The mean Gaitspeed was below 0.8 m/s, at 0.59 (0.3) indicating this population was at higher risk of falling and death. The mean MNA-SF was 11.8 (2.1) with 5.2% scoring in the malnourished range (<8) and 31.8% in the high risk (9 to 11) range. Multiple comorbidities were found in 85.3% of people and a mean of 6.0 (3.2) drugs were prescribed.

We had complete follow-up data for all 380 people. The total observation period was 18 months, mean 10.0 (5.5) months. There were 39 (10.3%) deaths, 48 (12.6%) NHTs and 93 (24.5%) discrete individuals admitted to hospital during the 18 months of follow-up.

The following variables were significantly associated with death (table 2 and online supplementary figures 1–6): CFS - HR 5.9 (95% CI 3.1 to 11.2); EQ-5D - HR 6.3 (95% CI 2.1 to 18.6); EQ-VAS - HR 7.0 (95% CI 2.3 to 20.9); Gaitspeed - HR 5.9 (95% CI 1.8 to 19.3); Gripstrength - HR 10.5 (95% CI 3.7 to 30.3); MNA-SF - HR 8.4 (95% CI 1.9 to 37.8); Hgb - HR 8.3 (95% CI 3.1 to 22.3); eGFR - HR 5.7 (95% CI 2.3 to 13.9); Cardiac Disease - HR 3.7 (95% CI 1.9 to 7.1) and Cancer - HR 2.7 (95% CI 1.0 to 7.1).

Table 2 and online supplementary figures 1-6 show that NHT was significantly associated with: CFS - HR 6.0 (95% CI 3.4 to 10.7); EQ-5D - HR 3.2 (95% CI 1.3 to 7.8); EQ-VAS - 3.4 (95% CI 1.2 to 9.4); Gaitspeed - HR 8.5 (95% CI 3.2 to 22.8); Gripstrength - HR 10.6 (95% CI 3.6 to 31.5); MNA-SF - HR 12.5 (CI could not be calculated because there were no events in the Q5 group); failed WST - HR 2.7 (95% CI 1.0 to 7.4); MoCA - HR 4.6 (95% CI 1.8 to 11.5) and GDS - HR 3.2 (95% CI 1.6 to 6.7). None of the medical diagnoses or laboratory values besides Dementia - HR 5.7 (95% CI 3.2 to 10.4) or Mood Disorder - HR 2.3 (95% CI 1.3 to 4.0) was associated with increased risk of NHT.

Table 2 and online supplementary figures 1-6 show that HA was significantly associated with: CFS - HR 2.9

Table 2 Predictors of death, nursing home transfer and hospital admission – HRs and 95% CIs

	Death n=39				Nursing home transfer n=48				Hospital admission n=93			
Variable	**HR**	**Lower limit**	**Upper limit**	**P value**	**HR**	**Lower limit**	**Upper limit**	**P value**	**HR**	**Lower limit**	**Upper limit**	**P value**
CFS (6-7/4-5)	5.92	3.12	11.22	<0.001	6.00	3.37	10.66	<0.001	2.92	1.93	4.40	<0.001
EQ-5D (Q1/Q5)	6.26	2.11	18.62	0.006	3.18	1.29	7.82	0.02	2.94	1.47	5.87	0.004
EQ-VAS (Q1/Q5)	7.00	2.34	20.93	0.003	3.38	1.22	9.35	0.03	6.69	3.20	13.99	<0.001
MoCA (Q1/Q5)	1.28	0.35	4.75	0.71	4.56	1.81	11.49	0.007	2.03	0.97	4.28	0.07
GDS (≥2/<2)	1.63	0.66	4.05	0.23	3.22	1.55	6.66	<0.001	2.45	1.18	5.10	0.02
Gait speed (Q1/Q5)	5.87	1.78	19.34	<0.001	8.51	3.18	22.79	<0.001	11.05	5.45	22.40	<0.001
Grip strength (Q1/Q4)	10.50	3.66	30.33	0.004	10.61	3.57	31.52	0.003	1.88	0.94	3.78	0.08
WST (fail/pass)	1.90	0.66	5.45	0.46	2.74	1.02	7.35	0.01	1.53	0.86	2.75	0.12
MNA-SF (Q1/Q5)	8.40	1.87	37.76	0.02	12.52	–	–	0.001	5.95	2.66	13.27	0.001
Haemoglobin (Q1/Q5)	8.34	3.12	22.31	0.001	0.88	0.38	2.05	0.77	2.27	1.14	4.52	0.02
eGFR (Q1/Q5)	5.65	2.30	13.90	0.002	1.59	0.66	3.82	0.30	2.45	1.28	4.72	0.01
HgbA1c (Q1/Q5)	0.62	0.23	1.66	0.74	0.42	0.08	2.08	0.63	1.34	0.65	2.75	0.06
Diseases (yes/no)												
Neurological	1.5	0.79	2.84	0.24	1.47	0.82	2.61	0.22	1.56	1.03	2.36	0.046
Respiratory	1.71	0.81	3.62	0.11	1.4	0.71	2.75	0.28	1.3	0.79	2.13	0.27
Cardiac	3.7	1.92	7.14	0.003	1.8	1	3.27	0.08	2.45	1.6	3.75	0.001
Hypertension	1.14	0.6	2.15	0.70	0.65	0.36	1.15	0.13	0.96	0.63	1.45	0.085
Cancer- active	2.66	0.99	7.11	0.006	1.31	0.54	3.16	0.51	1.41	0.72	2.76	0.24
Osteoporotic fracture	0.57	0.3	1.08	0.12	0.89	0.5	1.6	0.71	1.11	0.73	1.68	0.63
Osteoarthritis /chronic pain	1.39	0.73	2.63	0.33	1.15	0.64	2.04	0.65	1.59	1.05	2.39	0.04
Dementia	1.16	0.6	2.23	0.66	5.72	3.16	10.38	<0.001	1.49	0.97	2.29	0.05
Mood disorder	0.87	0.46	1.63	0.66	2.26	1.28	3.98	0.007	1.51	1.01	2.27	0.48
Multiple comorbidities	3.29	1.37	7.90	0.08	2.68	1.22	5.90	0.09	3.96	2.25	6.99	0.004
Number of drugs (Q5/Q1)	3.55	0.96	13.10	0.09	2.01	0.75	5.39	0.26	6.09	2.93	12.69	<0.001

CFS, Clinical Frailty Scale; eGFR, estimated glomerular filtration rate; EQ-5D, EuroQol EQ-5D-5L; EQ-VAS, EuroQol Visual Analogue Scale; GDS, Geriatric Depression Scale; HgbA1c, haemoglobin A1c; MNA-SF, Mini-Nutritional Assessment; MoCA, Montreal Cognitive Assessment; WST, water swallow test.

Table 3 Multivariate analyses - Cox proportional hazards model

Variable	Unadjusted HR (95% CI)	P value	Adjusted HR* (95% CI)	P value
Death				(<0.001)†
Clinical frailty scale	3.50 (2.15 to 5.71)	<0.001	2.88 (1.23 to 6.68)	0.014
EuroQol-VAS	0.96 (0.95 to 0.98)	<0.001	0.96 (0.93 to 0.98)	<0.001
eGFR	0.96 (0.95 to 0.98)	<0.001	0.97 (0.95 to 1.00)	0.04
Haemoglobin	0.97 (0.95 to 0.99)	<0.001	0.97 (0.94 to 0.99)	0.02
Nursing home transfer				(<0.001)†
Age	1.07 (1.01 to 1.12)	<0.01	1.10 (1.02 to 1.18)	0.02
Gait speed	0.10 (0.03 to 0.31)	<0.001	0.13 (0.03 to 0.57)	0.01
Geriatric depression scale	1.55 (1.25 to 1.91)	<0.001	1.39 (1.07 to 1.82)	0.01
Dementia diagnosis	5.75 (2.99 to 11.06)	<0.001	4.61 (1.86 to 11.44)	0.001
Hospital admission				(<0.001)†
Clinical frailty scale	2.04 (1.54 to 2.71)	<0.001	1.75 (1.21 to 2.51)	0.003
EuroQol-VAS	0.97 (0.96 to 0.99)	<0.001	0.98 (0.96 to 0.99)	0.004

*Adjusted for age, sex, multiple comorbidities, number of drugs and variables in final model.
†P for overall model.
eGFR, estimated glomerular filtration rate; VAS, Visual Analogue Scale.

(95% CI 1.9 to 4.4); EQ-5D - HR 2.9 (95% CI 1.5 to 5.9); EQ-VAS - HR 6.7 (95% CI 3.2 to 14.0); GDS - HR 2.5 (95% CI 1.2 to 5.1); Gaitspeed - HR 11.1 (95% CI 5.5 to 22.4); Hgb - HR 2.3 (95% CI 1.1 to 4.5); eGFR - HR 2.5 (95% CI 1.3 to 4.7); Cardiac Disease - HR 2.5 (95% CI 1.6 to 3.8); Osteoarthritis/Chronic pain - HR 1.6 (95% CI 1.1 to 2.4), Multiple Comorbidities - HR 4.0 (95% CI 2.3 to 7.0) and the Number of Drugs - HR 6.1 (95% CI 2.9 to 12.7).

Multivariate analysis using Cox proportional hazards model was used to calculate adjusted HR (aHR) (table 3). Death was independently associated with: CFS (aHR 2.88, 95% CI 1.23 to 6.68); EQ-VAS (aHR 0.96, 95% CI 0.93 to 0.98); eGFR (aHR 0.97, 95% CI 0.95 to 1.00) and Hgb (aHR 0.97, 95% CI 0.94 to 0.99). The p value for the model was <0.001. NHT was independently associated with: Gaitspeed (aHR 0.13, 95% CI 0.03 to 0.57); GDS (aHR 1.39, 95% CI 1.07 to 1.82) and Dementia (aHR 4.61, 95% CI 1.86 to 11.44). CFS was not statistically significant in this model when gait speed was added. The p value for the overall model was <0.001. HA was associated with CFS (aHR 1.75, 95% CI 1.21 to 2.51); EQ-VAS (aHR 0.98, 95% CI 0.96 to 0.99). The p value for the overall model was <0.001. No other diagnoses, multiple comorbidities, other frailty measures or number of drugs were significant in any of these models.

Table 4 shows that that CFS level predicted abnormal health status measures. All the frailty and health status measures were significantly worse for CFS levels 5 to 7 compared with CFS level 2 to 4.

Online supplementary table 1 compares the characteristics and outcomes for respondents and non-respondents. The 53 (13.9%) non-respondents were significantly more frail (mean CFS 6.0±0.8 vs 5.5±0.8) and were more likely to have a dementia diagnoses compared with respondents (n=31 (58.5%) vs 109 (33.3%)). All three outcomes were more common in the non-respondents. Online supplementary table 2 show that there was no appreciable difference in the HRs, CIs or p values for two representative

Table 4 Comparison of test scores by clinical frailty scale (CFS) level

Variable	CFS 2–4 n=38	CFS 5–7 n=342	P value
EuroQol EQ-5D-5L mean (SD)	0.84 (0.11)	0.71 (0.18)	<0.001
EuroQol visual analogue scale mean (SD)	82.09 (14.03)	70.22 (18.74)	<0.001
Gait speed mean (SD)	0.92 (0.29)	0.54 (0.28)	<0.001
Grip strength mean (SD)	23.54 (10.05)	15.21 (15.89)	0.002
Mini-nutritional assessment short form mean (SD)	12.78 (1.44)	11.67 (2.08)	0.002
Montreal cognitive assessment mean (SD)	26.00 (3.23)	19.84 (6.32)	<0.001
5-point geriatric depression scale mean (SD)	0.56 (0.88)	1.40 (1.36)	<0.001
Water swallow test - failure No. (%)	3 (8.3%)	64 (23.6%)	p=0.05

variables (EQ-5D and Gaitspeed) when imputed values were used for the survival analyses.

DISCUSSION

This study demonstrates that for an elderly population, simple tests for general frailty (CFS), physical health (Gaitspeed and MNA-SF) and HRQoL/self-reported general health (EQ-5D and EQ-VAS) strongly predicted the risk of death, NHT and HA. Additionally, measures of cognitive impairment (MoCA), mood (GDS) and dysphagia (WST) and Gripstrength predicted the risk of NHT and GDS predicted HA. Polypharmacy (number of drugs) and multiple comorbidities, both considered geriatric risk markers, predicted HA but not death nor NHT.

The frailty measures appeared to be stronger predictors of death than chronic disease diagnoses. These findings are consistent with other studies examining the relationship between functional decline, chronic diseases, health outcomes[43] and mortality.[44] For traditional medical diagnostic categories, cardiac disease and cancer were more weakly associated with death compared with frailty measures. Dementia and mood disorder predicted NHT. Cardiac disease and osteoarthritis/chronic pain weakly predicted HA. Low eGFR and Hgb were exceptions and strongly predicted death and less strongly predicted HA.

Kaplan-Meier curves (online supplementary figures 1–6) demonstrate that the high and low risk groups separate from each other early and that HRs are both clinically and statistically significant within 12 months. For example, these curves showed that the median survival for CFS Level 7 was 13 months (online supplementary figure 4), which is similar to stage 4 lung cancer[45] and significantly lower than for people with metastatic breast[46] or prostate cancer.[47] Therefore, prognostic information from these tests may be extremely valuable for patients and families deciding about the intensity of medical interventions that they want, as well as the need for community and institutional supports. These findings also show that frailty is not an 'all or none' risk phenomena but exists along a continuum.

There is overlap in what these tests measure which includes: function and symptoms (CFS/EQ-5D); physical problems (EQ-5D, MNA-SF, Gaitspeed and Gripstrength) and mental health problems (EQ-5D, GDS, MoCA and MNA-SF). It is tempting to rely on one measure such as the CFS which simply classifies frailty and strongly predicted adverse outcomes. However, it does not tell us about an individual's mood, cognitive function, strength, gait and balance, HRQoL, chronic symptoms, swallowing problems or nutritional risk. In addition to measuring unique dimensions of health status, these tests may change over time and be modifiable risk markers. While it is unusual for people with chronic frailty to improve to a better CFS level, there is evidence that EQ-5D, EQ-VAS, Gaitspeed, Gripstrength, MNA-SF, GDS and MoCA may be modifiable and that improvements in scores may lower peoples' risk for adverse outcomes.[32 33 48–52] Each of these tests is responsive to change in health and have minimally clinical important differences established,[51 53–60]. Therefore, repeating these tests may be useful to assess interventions (eg, a medication change or rehabilitation treatment) for individual patients as well as to evaluate aggregated changes for a programme. We are planning to use this data to evaluate our interdisciplinary team interventions for individuals and to aggregate the before/after data to evaluate our programme.

Reduced HRQoL at baseline, as measured by the EQ-5D, was shown to be a strong risk factor for adverse outcomes. These findings are consistent with other studies for general[61] and elderly populations.[62] HRQoL is arguably not only a risk factor, but one of the most important outcome measures and goals of care for elderly people. The EQ-5D is the only test that may be complex to use and interpret. It requires the use of population norms and conversion into a summary index which can be loosely interpreted as an assessment of how people value their current health status.[21] The EQ-VAS, which uses a 100-point vertical visual analogue scale for general health was a very simple test and strong predictor for all outcomes. The scores for the EQ-VAS and EQ-5D were remarkably similar in our study with a correlation coefficient of 0.48 p<0.001. Therefore, it may be possible to use the EQ-VAS as a proxy measure for HRQoL when software or population norms for the EQ-5D are not readily available. We were able to benchmark our population and show that when HRQoL as measured by EQ-5D and EQ-VAS drops below 0.7/70 (Quintile 1), risk for death, NHT and HA significantly increased.

These tests were administered by a trained nurse, but all or parts of the FACTS assessment could easily be administered by any trained team member. The cost of administering the complete assessment was 1 hour of nursing time. This is less costly than a typical battery of blood tests or scans done for a geriatric assessment. Most of the individual tests took less that 5 to 10 min to administer.

The results from the bivariate analyses show that not all elderly people need to have a complete FACTS assessment. The mean test values were largely in the normal range for CFS <5. Therefore, well elderly people could initially be screened with the CFS and if the level is ≥5, more complete testing could be done.

Strengths and limitations

The strengths of this study are the inclusion of a large number of very old and frail people, high test administration rates and complete follow-up of outcomes. The pragmatic nature of this study of 'usual care' with assessments done by the practice nurses adds to its generalisability. The tests used have been well studied and shown to be valid, reliable and responsive across populations, for different diseases and in different clinical settings[32 38 49 52 63–72]. The unique aspect of this study is using these health status tests to measure multiple domains of health, including HRQoL in a primary care setting and aggregating the results to predict adverse outcomes. There was a relatively

low non-response rate to the frailty tests confirming that this assessment is well tolerated and acceptable to most frail elderly people in a practice setting.

Non-responders were slightly frailer on the CFS, more likely to have dementia and had higher rates of the three outcomes. However, analysis with imputed values for missing data did not diminish the strength of the HRs or statistical significance, indicating there was not a response-rate bias compromising the results.

The limitations of this study are that the results, including absolute risks and time-to-event may not be generalisable to 'younger elderly' groups or non-elderly populations with disabilities. Similarly, we cannot generalise these results to a non-frail elderly population or frail people living in nursing homes or being treated in hospitals. This study only involved one practice. Further testing would need to be done to scale and generalise this model of assessment for epidemiological tracking and programme evaluation for larger healthcare populations (eg, an health maintenance organisation, regional family medicine network or geriatric consulting programme). We did not control for socioeconomic status and social risk factors because our population largely came from homogeneous middle and upper-middle class backgrounds. We also had very low completion rates for questionnaires pertaining to caregiver burden, so we were unable to examine this risk factor as part of this study. The small number of values in the subgroups may have led to Type 2 Errors. It is possible that the lack of association with multiple comorbidities was due to the high frequency of disease in this population and an inadequate number of internal controls. There were multiple comparisons in this study, but the key results were highly significant and consistent, making it unlikely the findings were due to random error.

It is possible that there was measurement bias because practice nurses who knew the patients performed the assessments. However, the nurses did not record outcomes and the prospective design limited this possibility.

CONCLUSIONS

For an elderly population, simple measures of physical health, mental health, HRQoL and general frailty, administered as part of usual medical care are stronger predictors of mortality, NHT and HA than traditional medical diagnoses. Consideration should be given to incorporating these measures into routine medical care.

Acknowledgements Elizabeth Zacharias MSc for assisting with the audit and reviewing the manuscript. Dr Margaret McGregor, Head Community Geriatrics, Department of Family Practice University of British Columbia, for supporting this research with a financial grant. Joyce Constantine - Island Health Library Services for assisting with the literature review. Dr Jonathan Berkowitz for his statistical consultation.

Contributors TR conceived the host study. TR, PM, VH and RL planned the study and protocol. VH planned the test administration, trained nurses and was involved in the data collection. TR, VH and RL planned the data management and abstraction. TR performed the statistical analyses. TR and PM conceived the manuscript idea, drafted the manuscript and revised the manuscript for content. All authors reviewed the final manuscript and have contributed significantly to the work presented within this manuscript have been listed above.

Funding The FACTS study was supported with a grant from the section of Community Geriatrics, Department of Family Practice, University of British Columbia.

Competing interests None declared.

Patient consent for publication Not required.

Ethics approval This study was approved by the University of British Columbia Clinical Research Ethics Board (H15-03528).

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request.

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