The Frailty Trajectory's Additional Edge Over Frailty Index: A Retrospective Cohort Study in Veterans with Heart Failure

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Submitted to: JMIR Aging
on: January 13, 2024

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Abstract

Background: Individuals with heart failure (HF) have a high burden of health care utilization, cost, and morbidity in the year following hospitalization for an acute HF exacerbation. Frailty, described as increased vulnerability to adverse events, is common among those with HF and increases with age1. Health systems worldwide are integrating automated tools within electronic health records (EHR) to measure frailty. However, the consideration of longitudinal data to measure frailty to better predict outcomes among those with HF is lacking2-5.

Objective: We sought to evaluate the predictive value of adding longitudinal data to a standard frailty index and evaluate prediction of 1-year outcomes in patients with heart failure.

Methods: This was a retrospective cohort study using national Veterans Health Administration (VA) data. Veterans aged 50 and older with an index hospital admission for heart failure between calendar years 2016-2019 were included. Subjects had 2+ primary care visits in past three years before date of admission to indicate regular use of VA care and a documented ejection fraction (EF). We used the validated VA frailty index (FI) which captures 31 deficits in health based on International Classification of Diseases 10th and Current Procedural Terminology codes.6 We fit a linear line to three calculated FIs for each year prior to index date of admission and reported the slope and intercept individually. This method provides a three-year longitudinal estimate of frailty at admission. We used 1-year, all-cause mortality following the index of admission as the outcome. We reported the Area under the curve (AUC) for predicting outcomes using logistic regression. We estimated two AUCs: a) FI at the time of admission (AUCFI) and b) FI at time of admission plus slope and intercept (AUCFT+FI). Changes in the AUCs are reported as percentage of improvement [?AUC=100% * (AUCFT+FI-AUCFI)/AUCFI]. We recursively calculated the AUCs and ?AUC by including patients whose FI at admission were less than 0.1 and at each step, increased the FI level by 0.01 to 0.4.

Results: In total, 54,774 Veterans were included. Average age was 73±10 years (BMI 30±7 Kg/m2; 98% male; 55% White, Table 1). Figure 1 shows the AUCFI and AUCFT+FI across the distribution of frailty ranges from prefrail (FI?0.10 to <0.2) to frail. An FI of 0.2 is equivalent to an accumulation of 7 deficits among 31 variables. The ?AUC is also displayed. Across all AUCs evaluated for Veterans at different thresholds of FI the AUC improved 4.1% by adding FT to the FI. The highest ?AUC observed at FI of 0.13 to 0.16 (24%) and reduced to 10% for FI of 0.2 and greater.

Conclusions: In a national cohort of Veterans admitted with HF, the addition of longitudinal frailty trajectory data resulted in a clinically significant (24%) improvement in one-year mortality prediction compared to a standard FI alone among patients in the prefrail range. In contrast, we observed a modest (4%) improvement in one-year mortality prediction in the overall population. Enhancing AUC prediction in prefrail range is clinically important as interventions to mitigate frailty may be most impactful in this population7. In particular, prefrail patients may benefit from interventions, such as cardiac rehabilitation, to improve frailty

status and cardiovascular outcomes1. These results may not generalize to non-Veteran populations. The sample is predominately male but does include a diverse population by race, ethnicity and geographic distribution. In summary, methods for calculating frailty provide useful predictions of adverse outcomes among adults with HF. The addition of longitudinal data particularly improves predictions for prefrail patients with HF. These findings aide clinician and health system decision making as this population benefits most from interventions to slow or prevent progression of frailty.

(JMIR Preprints 13/01/2024:56345)
DOI: https://doi.org/10.2196/preprints.56345

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Title

The Frailty Trajectory's Additional Edge Over Frailty Index: A Retrospective Cohort Study in Veterans with Heart Failure

Brief title:

Frailty Trajectory versus Frailty Index

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Word Count (text only): 528

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Introduction

Individuals with heart failure (HF) have a high burden of health care utilization, cost, and morbidity in the year following hospitalization for an acute HF exacerbation. Frailty, described as increased vulnerability to adverse events, is common among those with HF and increases with age[1]. Health systems worldwide are integrating automated tools within electronic health records (EHR) to measure frailty. However, the consideration of longitudinal data to measure frailty to better predict outcomes among those with HF is lacking[2-5]. We sought to evaluate the predictive value of adding longitudinal data to a standard frailty index and evaluate predictions of 1-year outcomes in patients with heart failure.

Methods

This was a retrospective cohort study using national Veterans Health Administration (VA) data. Veterans aged 50 and older with an index hospital admission for heart failure between calendar years 2016-2019 were included. We exclude subjects with less than 2 primary care visits in the past three years before date of admission to indicate regular use of VA care. We included those with documentation of ejection fraction (EF). We used the validated VA frailty index (FI) which captures 31 deficits in health based on International Classification of Diseases 10th and Current Procedural Terminology codes.[6]. We estimated the FI for preceding each year without overlap. We fit a linear line to three calculated FIs for each year prior to index date of admission and reported the slope and intercept individually. This method provides a three-year longitudinal estimate of frailty at admission. We used 1-year, all-cause mortality following the index of admission as the primary outcome. We reported the Area under the curve (AUC) for predicting outcomes using logistic regression. We estimated two AUCs: a) FI at the time of admission (AUC_{FI}) and b) FI at time of admission plus slope and intercept (AUC_{FT+FI}). Changes in the AUCs are reported as percentage of improvement [Δ_{AUC}=100% * (AUC_{FT+FI}-AUC_{FI})/AUC_{FI}]. We recursively calculated the AUCs and Δ_{AUC} by including patients whose FI at admission were less than 0.1 and at each step, increased the FI level by 0.01 to 0.4.

Results

In total, 54,774 Veterans were included. Average age was 73±10 years (BMI 30±7 Kg/m^2; 98% male; 55% White, **Table 1**). **Figure 1** shows the AUC_{FI} and AUC_{FT+FI} across the distribution of frailty ranges from prefrail (FI≥0.10 to <0.2) to frail. An FI of 0.2 is equivalent to an accumulation of 7 deficits among 31 variables. The Δ_{AUC} is also displayed. Across all AUCs evaluated for Veterans at different thresholds of FI the AUC improved 4.1% by adding FT to the FI. The highest Δ_{AUC} observed was at FI of 0.13 to 0.16 (24%) and reduced to 10% for FI of 0.2 and greater.

Discussion

In a national cohort of Veterans admitted with HF, the addition of longitudinal frailty trajectory data resulted in a clinically significant (24%) improvement in one-year mortality prediction compared to a standard FI alone among patients in the prefrail range. In contrast, we observed a modest (4%) improvement in one-year mortality prediction in the overall population. Enhancing AUC prediction in the prefrail range is clinically important as interventions to mitigate frailty may be most impactful in this population[7]. In particular, prefrail patients may benefit from interventions, such as cardiac rehabilitation, to improve frailty status and cardiovascular outcomes[1]. These findings enrich our understanding of the importance of frailty trajectory in patient at lower levels of the frailty index while previous study compared the importance of current FI in comparison to FT alone [5]. These results may not generalize to non-Veteran populations. The sample is predominately male but does include a diverse population by race, ethnicity and geographic distribution. In summary, methods for calculating frailty provide useful predictions of adverse outcomes among adults with HF. The addition of longitudinal frailty data improves predictions for prefrail patients with HF. These findings aide clinician and health system decision making as this population benefits most from interventions to slow or prevent progression of frailty. The findings of this study suggests that longitudinal data to model frailty trajectory provides additional evidence to tailor interventions to patient with HF who may benefit most.

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Table 1

Table1. Characteristics of patients (N=54,774) with an index admission to the Veterans Health Administration for heart failure between 01/01/2016 to 01/01/2020.

n	54,774
Admit Year 2016	12,875(23.5)
Admit Year 2017	13,585 (24.8)
Admit Year 2018	14,082(25.7)
Admit Year 2019	14,232(26.0)
Age, M(SD)	73.3(10.1)
age, <65, N(%)	9,776(17.8)
age, 65-75, N(%)	22,772(41.6)
age, >= 85	22,226(40.6)
Sex, Male, N(%)	53,899 (98.4)
Race	
White	30,406 (55.5)
Black	9,340 (17.1)
Others†	15,028 (27.4)
Ethnicity, Hispanic, N(%)	2,093 (3.8)
BMI, M(SD)	30.1(7.5)
BMI, >= 30, N(%)	24,352(44.5)
Frailty Status. M(SD)	0.35(0.11)
Robust, <0.1, N(%)‡	297 (0.5)
Pre-frail, 0.1-0.2, N(%)‡	5,715 (10.5)
Frail, ≥0.2, N(%)‡	48,762 (89.0)
All-Cause Mortality	
30-Day, %	5.2
1 Year, %	26.4
All time, %	67.6
Time-to-Death, M(IQR)	18.2(5.6, 36.4)
HFrEF, %	49.7
HFmEF, %	8.3
HFpEF, %	42.0
CLC, %	3.3

M(SD) = mean and standard deviation, M(IQR) = median and inter quartile.

BMI = body mass index, HFrEF = heart failure with reduced ejection fraction ≤ 40%, HFmEF = heart failure with modified reduced ejection fraction > 40% & ≤50%, HFpEF = heart failure with preserved ejection fraction > 50%, CLC = Community Living Centers.

† other includes Asian, American Indian or Alaska Native, Native Hawaiian or Other Pacific Islander, and unknown.

‡ Standardized frailty status cut-points drawn from validated studies[6].

Figure 1.

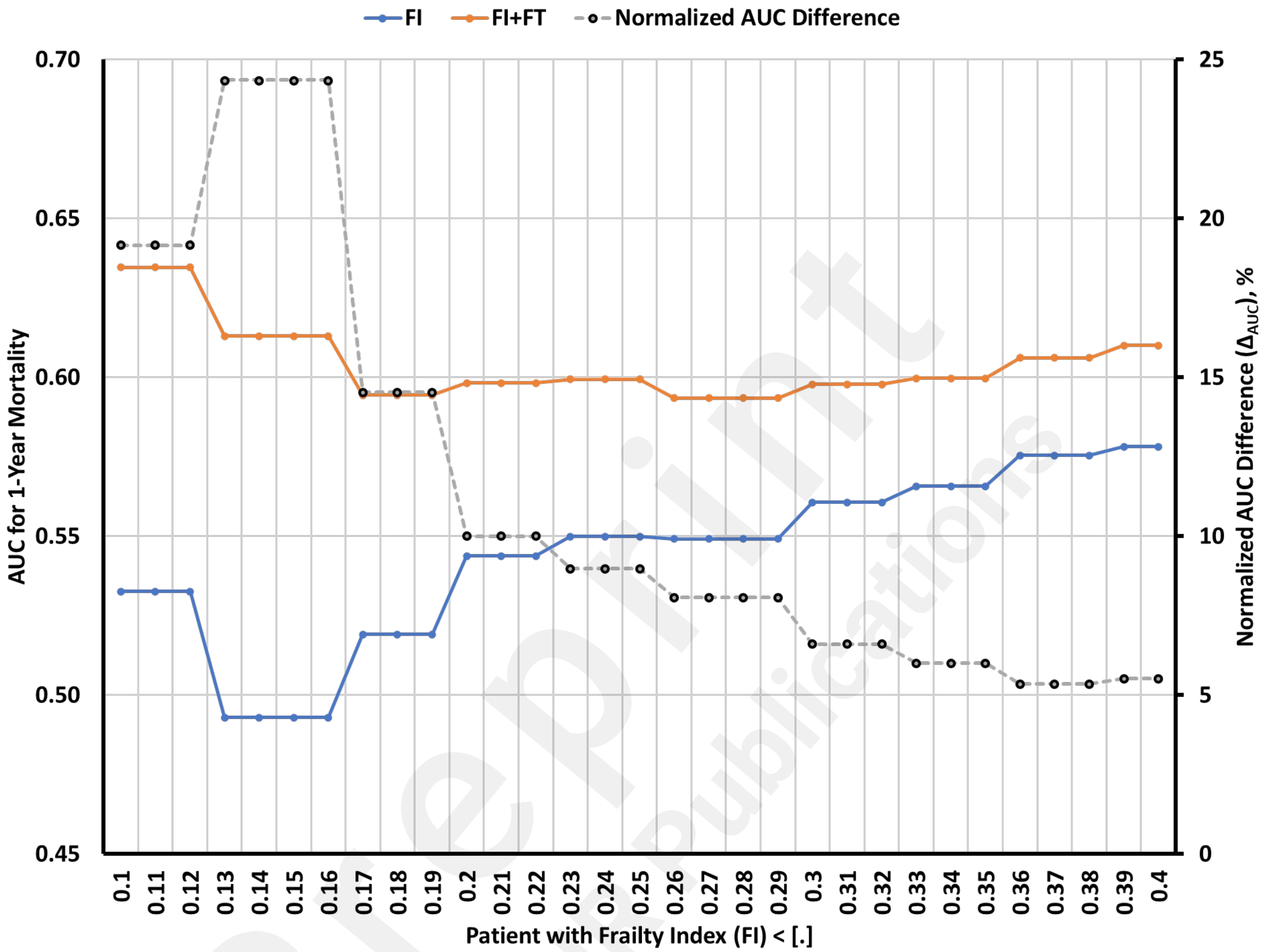

Figure 1. Area under the curve (AUC) for patients admitted for the first time in Veterans Health Administration (VHA) for heart failure from 01/01/2016 to 01/01/2020. We compared the AUC of frailty index (FI) in blue (AUC_{FI}) versus AUC of FI and frailty trajectory (FT) combined in orange (AUC_{FI+FT}). The percentage of improvement in AUC by adding FT over the FI was reported in black (Δ_{AUC}) using the following formula: $\Delta_{AUC} = \frac{(AUC_{FI+FT} - AUC_{FI})}{AUC_{FI}} \times 100$.