HHS Public Access
Author manuscript
J Surg Res. Author manuscript; available in PMC 2021 January 01.

Published in final edited form as:
J Surg Res. 2021 January ; 257: 326–332. doi:10.1016/j.jss.2020.08.007.

A Prospective Comparison of Frailty Scores and Fall Prediction in Acutely Injured Older Adults

Shawn Tejiram, MD[a], **Julia Cartwright, BA**[b], **Sandra L. Taylor, PhD**[c], **Victor H. Hatcher, MHS**[d], **Colette Galet, PhD**[e], **Dionne A. Skeete, MD**[e], **Kathleen S. Romanowski, MD**[a,*]

[a]Division of Burn Surgery, Department of Surgery, University of California, Davis, Sacramento, California

[b]School of Medicine, University of Michigan, Ann Arbor, Michigan

[c]Division of Biostatistics, Department of Public Health Sciences, University of California Davis, Sacramento, California

[d]Carver College of Medicine, University of Iowa, Iowa City, Iowa

[e]Division of Acute Care Surgery, Department of Surgery, University of Iowa, Iowa City, Iowa

Abstract

Background: Elderly (65 and older) fall-related injuries are a significant cause of morbidity and mortality. Although frailty predicts poor outcomes in geriatric trauma, literature comparing frailty scoring systems remains limited. Herein, we evaluated which frailty scoring system best predicts falls over time in the elderly.

Materials and methods: Acute surgical patients 65 y and older were enrolled and prospectively observed. Demographics and frailty, assessed using the FRAIL Scale, Trauma Specific Frailty Index (TSFI), and Canadian Frailty Scale (CSHA-CFS), were collected at enrollment and 3 mo intervals following discharge for 1 y. Surveys queried the total number and timing of falls. Changes in frailty over time were assessed by logistic regression and area under the curve (AUC).

Results: Fifty-eight patients were enrolled. FRAIL Scale and CSHA-CFS scores did not change over time, but TSFI scores did ($P \leq 0.01$). Worsening frailty was observed using TSFI at 6 ($P \leq 0.01$) and 12 mo ($P \leq 0.01$) relative to baseline. Mortality did not differ based on frailty using any frailty score. Increasing frailty scores and time postdischarge was associated with increased odds of a fall. AUC estimates with 95% CI were 0.72 [0.64, 0.80], 0.81 [0.74, 0.88], and 0.76 [0.68, 0.84] for the FRAIL Scale, TSFI, and CSHA-CFS, respectively.

Corresponding author: University of California, Davis and Shriners, Hospitals for Children Northern California, Stockton Boulevard, Suite 718, Sacramento, CA 95762. Tel.: +916 453-5022; fax: +916 453-2373., ksromanowski@ucdavis.edu (K.S. Romanowski).
Author contributions:
All authors have made equal contributions to the conception, design, analysis, interpretation, drafting, and revision of the manuscript for this study.

Disclosure
The authors reported no proprietary or commercial interest in any product mentioned or concept discussed in this article.

Supplementary data
Supplementary data to this article can be found online at https://doi.org/10.1016/j.jss.2020.08.007.

Conclusions: The risk of falls postdischarge were associated with increased age, time postdischarge, and frailty in our population. No scale appeared to significantly outperform the other by AUC estimation. Further study on the longitudinal effects of frailty is warranted.

Keywords

Frailty; Geriatric; Elderly; Trauma

Introduction

The elderly adult population aged 65 y and older is expected to double in size by the year 2060.[1,2] Fall-related injury represents a significant portion of traumatic injury in the elderly, and this population is particularly vulnerable to repeat fall episodes.[3–5] Each year, up to 30% of the elderly population experiences at least one or more falls. The morbidity following a fall-related traumatic injury can exacerbate fears of repeat fall episodes that reduce activity and further perpetuates increased debilitation.[1,6,7] Frail postsurgical patients may similarly be at risk for debilitation and fall in the postop period.[8–10] Despite identifying this group as a vulnerable population, the incidence of both geriatric fall-related trauma admissions and recidivism continues to rise.[11]

There is increasing interest in identifying models and scoring systems that better predict and identify elderly individuals most at risk for falls. Frailty considers the physiologic, environmental, and behavioral characteristics of an elderly patient to determine their vulnerability to an adverse event.[12–14] In geriatric trauma patients, frailty has been identified as a major predictor of poor outcomes and has since been incorporated as a prognostication tool in the acute injury setting.[15,16] Several validated scoring systems have been developed to determine frailty. Each frailty scoring system weighs patient attributes differently and may incorporate a few or many variables into their evaluation. Frailty scoring systems such as the FRAIL Scale and Canadian Study on Health and Aging Clinical Frailty Scale (CSHA-CFS) are generally based on established epidemiology of the general geriatric population and consider specific cognitive impairment or other health issues. Meanwhile, the Trauma Specific Frailty Index (TSFI) is based on variables predictive of discharge disposition in geriatric trauma patients.[8]

The FRAIL Scale considers five attributes: the presence of fatigue, the ability to climb stairs, difficulty with ambulation, comorbidities (greater than 5), and unexpected weight loss (greater than 5% in a 12-mo period). The number of positive attributes in the FRAIL Scale is counted; three or more positive attributes identify a patient as frail. The advantage of this scale is its utility as a rapid assessment tool that can be conducted quickly when assessing patients in the acute setting.[17–19] The Trauma Specific Frailty Index (TSFI), in comparison, incorporates fifteen variables into its assessment and considers patient attributes such as comorbidities, ability to perform activities of daily living, presence of dementia, and general life attitudes to ultimately determine frailty.[20] Each variable is worth one point but may be fractionated depending on the degree of disease or answer; for example, mild dementia is worth 0.25 points, whereas severe dementia is worth 1 point. The total score is then divided by 15 to determine a score range from 0 to 1. Patients with TSFI scores greater than 0.27

have been shown to be more likely to have an unfavorable discharge disposition to a skilled nursing facility or death, and this score is generally used as the cut off to identify frail patients.[8,20] The Canadian Study of Health and Aging Clinical Frailty Scale (CSHA-CFS) is a seven-point scale that considers attributes such as comorbidities, ongoing active disease management, dependence on others, and ability to perform activities of daily living. In this frailty assessment system, scoring is determined by clinical opinion following patient assessment. A patient with a score of 5 or greater is considered frail.[9,21] Frailty scoring systems must additionally consider the rapidity with which they can be performed to assess a patient. A scoring system examining more attributes may more accurately identify someone as frail but may not be an ideal point of care assessment in the acute injury setting.

For elderly patients who are admitted for acute illness or trauma, frailty assessment typically occurs at the time of injury or admission and does not consider the long-term dynamics of patient management or rehabilitation as their course and disposition evolve over time. As a result, literature comparing patient frailty scores directly, and how their scores change over time remains limited. In this study, we sought to evaluate three scoring systems to (1) assess whether frailty scores changed over time, and (2) evaluate relationships between falls and the three frailty scoring systems.

Methods

This study was conducted under the approval of the University of Iowa Institutional Review Board (IRB # 201611731). Participants were consented and enrolled upon presentation to our institution after determining that they met inclusion criteria and then prospectively observed for 1 y following discharge.

Inclusion and exclusion criteria

Patients aged 65 y and older with an acute injury or acute surgical illness and admitted to a University of Iowa Hospitals and Clinics service lines of burn, trauma, or emergency general surgery from December 2016 to June 2017 were included in this study. Injury types included acute traumatic injury such as falls or penetrating injuries, acute burn injury. Those who required emergency general surgery for acute surgical illness were also included. NonEnglish speakers, patients who were unable to answer questions about their health and social situation, or those who did not have a family member or equivalent proxy that were familiar with the patient's prior and current level of functioning or medical history, as well as their fall behavior at the time of the study, were excluded.

Frailty scoring

Variables to determine frailty scores were obtained by surveys collected starting at enrollment and subsequently over the course of a year following discharge. Surveys collected included information on demographics, general health and comorbidities, and objective information necessary to help determine frailty scores by FRAIL Scale, TSFI, and CSHA-CFS assessment. A representative image of the survey's first page is depicted in Figure. Inquiries made by the survey included questions asking for demographic information, education level, and past medical history. Additional questions pertaining to general health and quality of life included assessments of visual and hearing acuity, ability to ambulate, actual or perceived obstacles to traversing pathways or stairs, need for assistive devices or assistance in general, as well as self-assessment of ability to conduct general activities of daily living. The full survey is available as supplementary material for reference (Supplement 1).

Frailty scores were re-evaluated at 3, 6, 9, and 12 mo intervals following discharge. Fall information was queried from patients by a survey for recent falls within the last week of survey administration, their total number of falls, and any other related fall information. Falls were re-evaluated at 1, 2, 3, 4, 6, 8, 10, 12, 16, 20, 24, and 52 wk following discharge. Subjects completed surveys at their regularly scheduled follow up appointments, over the phone, via email, or by paper mail.

Demographic data collection

Medical records and surveys were reviewed for demographic information that included age, gender, race, co-morbidities, substance abuse history, occupation, height, and weight. Additional information pertaining to hospital course and management included length of stay, follow up and repeat admissions, any associated complications related to their hospital stay, nutritional status, and assessments, participation with therapy, any trauma-related data, and discharge disposition were collected.

Statistical analysis

For assessing change in frailty scores over time, a linear marginal model with Gaussian errors was used to relate each frailty metric to time expressed in months as a categorical variable. For accounting the correlation of observations from the same subject, the correlation structure was modeled. Several correlation structures (unstructured, compound symmetry, autoregressive, and Toeplitz) were evaluated for each frailty metric and model fit compared using Akaike Information Criteria.[22,23] The correlation structure yielding the lowest AIC value was used to fit the final model. For the FRAIL Scale and TSFI, compound symmetry was assumed, while for the CSHA-CFS, the Toeplitz correlation structure was best. Models were fit using Proc Mixed in SAS version 9.4 (SAS Institute Inc, Cary, NC). Only 9 subjects died. Due to the small number of deaths, to assess a potential association between mortality and frailty, two-sample t-tests with equal variance were used to compare baseline frailty metrics between survivors and nonsurvivors. Subjects lost to follow up were not included in this analysis.

Logistic regression was used to evaluate changes in the log odds of a fall over time and the effect of frailty with age included as a covariate. For accounting the correlation within each subject, generalized estimating equations were used to estimate parameters and the covariance matrix estimated with a robust sandwich estimator. An independence structure was assumed for the working correlation matrix. Age was centered at 65. The week was modeled as a continuous variable, as were all frailty metrics. Models were fit for each frailty metric using Proc Genmod. Changes in the log odds of a fall over time were assessed using logistic regression and the area under the curve (AUC) was calculated. For determining the sensitivity and specificity of each frailty score determined at enrollment to predict any fall during the year of follow up, frailty was dichotomized as frail or not, and the sensitivity, specificity, negative predictive value, and positive predictive value were calculated for each frailty scoring system. Frail patients were defined as patients with a FRAIL Scale score of 3 or greater, TSFI score above 0.27, and CSHA-CFS score of 5 or greater. $P < 0.05$ was considered significant.

Results

Patient characteristics

Fifty-eight patients were enrolled upon presentation. Among those, 31 patients were admitted to our institution's trauma service, 19 to the emergency general surgery service, and 8 to the burn surgery service. Patients were then followed prospectively during their hospital course and over the course of a year postdischarge. Twenty-eight patients were discharged home, 18 to a skilled nursing facility (SNF), 6 to a long-term acute care hospital (LTACH), and 5 to an inpatient rehabilitation facility. Nine patients were reported to have died over the course of the study. One participant did not have entries for the frailty metrics at enrollment and was dropped from this analysis. No significant differences in frailty scores were observed when comparing alive patients to those who died over the course of the study, regardless of the scale used: FRAIL scale (0.95 ± 0.18 *versus* 1.38 ± 0.38, $P = 0.34$), TSFI (0.21 ± 0.03 *versus* 0.30 ± 0.07, $P = 0.17$), and CSHA-CFS (3.90 ± 0.23 *versus* 4.75 ± 0.41, $P = 0.13$). Discharge disposition was not predictive of survival to the end of the study (data not shown). Patient characteristics, past medical history, admission frailty scores, and frailty status are presented in Table 1. A review of median frailty ranges for each respective frailty scoring system revealed amix of patients presenting as frail and nonfrail.

Frailty metrics reliability

One of the goals of this study was to assess the reliability of frailty scoring systems in predicting both mortality and falls. The sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of each frailty scale in predicting mortality and falls are presented in Table 2. Overall, the concordance for all three frailty scoring systems was 40/54 (74%). Fleiss Kappa for frailty at the start of the study was 0.65 [0.50, 0.81] and showed an overall agreement of 83%. The FRAIL Scale had the highest specificity in both mortality and falls, while the TSFI and CSHA-CFS had better sensitivity relative to the FRAIL Scale in both groups. PPV and NPV remained relatively unchanged among the groups. Twenty-two patients were found to be frail on any of the scales. Eight patients were found to be frail on all the scales (36%). The same frail subjects ($n = 14$) were detected using the CSHA-CFS and TSFI except for eight cases. Four were considered frail on the CSHA-CFS, but not on the TSFI, and four were frail on the TSFI, but not on the CSHA-CFS.

Frailty metrics over time

FRAIL scale scores ($P = 0.46$) and CSHA-CFS scores ($P = 0.54$) did not change significantly over time, but TSFI scores did ($P \leq 0.01$). Mean TSFI scores increased over time from 0.23 [0.19, 0.28] at enrollment to 0.26 [0.22, 0.31], 0.28 [0.23, 0.33], 0.28 [0.24, 0.33], and 0.30 [0.25, 0.34] at 3, 6, 9, and 12 mo postdischarge, indicating worsening scores.

Pairwise comparisons of means between time points with Tukey's posthoc pair comparison procedure showed significant worsening in frailty at 6 ($P \leq 0.01$), 9 ($P \leq 0.01$), and 12 mo ($P \leq 0.01$) relative to baseline. While the point estimates showed continued worsening at 12 mo and estimated mean values at 9 and 12 mo were significantly worse than that at baseline, differences in mean TSFI for months 3 through 12 did not reach statistical significance.

The log odds of a fall were modeled as a function of the week since discharge, patient age centered at 65, and the last available frailty score for each week (Table 3). Based on this model, the log odds of a fall were noted to increase with patient age in all analyses, although the effect was only statistically significant when using the FRAIL Scale ($P = 0.01$). The estimated relationship was similar for all three scoring systems with the log odds of a fall increasing by 0.03 to 0.06 per year increase in patient age with 95% confidence intervals encompassing a range of 0.01 to 0.11 for the FRAIL Scale and 0 for the TSFI and CSHA-CFS scales. The log odds of a fall also increased over time, and time (week) was statistically significant for all three scoring systems. The relationship was consistent among the scoring systems with coefficients ranging from 0.03 to 0.04, indicating an increase in the odds of a fall of 3% to 4% per week since discharge with the 95% confidence intervals ranging from 1% to 6%. Finally, for all frailty metrics, an increase in frailty was associated with an increase in the odds of a fall. The odds ratios [95% CI] for a one-unit change in FRAIL scale scores was 1.89 [1.34, 2.67] and CSHA-CFS scores was 2.38 [1.55, 3.64]. As TSFI can only range from 0 to 1, for a 0.01 unit change, the odds ratio for TSFI was 1.08 [1.04, 1.01].

Comparison of frailty scores

ROC curves were created for each regression to allow comparison among frailty scoring systems. AUC estimates with 95% CI were 0.72 [0.64, 0.80], 0.81 [0.74, 0.88], and 0.76 [0.68, 0.84] for the FRAIL Scale, TSFI, and CSHA-CFS, respectively. Although the highest estimates were observed for TSFI, overlapping confidence intervals ultimately showed that no scoring system was significantly better than the other.

Discussion

Fall-related trauma in the elderly remains a significant problem. Over two million elderly patients are treated yearly in emergency departments for a fall-related injury and it accounts for up to 15% of all emergency department visits.[11] A review of the World Health Organization mortality and National Readmission databases for elderly patients aged over 65 y who sustained fall-related trauma noted an increase in fall-related death and 30-day recidivism for subsequent falls.[11] Frailty assessment remains a useful tool to assess risk, determine adverse event prevention, and anticipate upcoming needs.[8]

Many frailty scoring systems remain in use for prognostication beyond what is discussed in this study. For example, on a retrospective analysis of elderly burn patients, Maxwell *et al.* developed a Burn Frailty Index that predicted frailty and associated outcomes in an elderly burn-injured population.[24] A review of the ACS-TQIP database examined over 34,000 patients for frailty using a modified frailty index (mFI) derived from the CSHA that assesses 11 variables comprising of 10 comorbidities and one functional status measure to predict complications and mortality.[25] Despite this, studies examining the validity of these scoring systems remain limited. A systematic review to examine available frailty clinical assessment tools and evaluate their use in geriatric trauma identified few assessment tools as objective, feasible, or useful.[26] In our cohort, all scoring systems had low sensitivity overall, making each test generally insufficient for screening purposes. The FRAIL Scale had a higher specificity than the TSFI or CSHA-CFS for falls and mortality, which may make it a better confirmatory test following initial frailty assessment.

We identified a statistically significant increase in the Trauma Specific Frailty Index at 6, 9, and 12 mo relative to baseline. In comparison to other frailty scoring systems, TSFI was the only scoring system to exhibit a significant difference over time. Frequent reassessment of patient frailty may be necessary to identify physiologic or qualitative changes in a patient's hospital course or recovery. We did show that the log odds of a fall increased over time in TSFI scores. Additionally, increased overall frailty was associated with an increased odds of a fall. Frailty scoring systems that are able to exhibit meaningful changes in patient status are critical to properly assess frailty at presentation and over time.

Most literature examining frailty typically utilizes a one-time evaluation of frailty to determine outcomes. In this context, this study presents a unique approach to evaluating frailty in that it examines changes in frailty over time. In our cohort, using the TSFI, we were able to identify worsening frailty over the course of the year relative to baseline, and those changes were identified as soon as 6 mo following the initial evaluation. This underscores the importance of frequent reassessments of frailty, as well as identifying those changes early. Bryant *et al.* identified frail elderly patients aged 65 y and older to assess whether a prospective interdisciplinary protocol consisting of early ambulation, bowel and pain regimens, nonpharmacologic delirium prevention, nutritional and physical therapy consultation, and geriatric assessments could affect outcomes. They found significant decreases in delirium and 30-d recidivism compared to frail patients with no intervention.[27] Identifying frailty changes with increased frequency can help tease out the nuances of frailty measurements and can better identify pathologic changes in frailty that may require intervention. These frailty scoring systems could furthermore be utilized in the outpatient setting by primary care providers in initial and subsequent well visits. Knowledge of frailty at the start of acute injury management may be useful in therapeutic decision making.

There are several limitations to this study. This study represents an initial analysis of acutely injured patients to evaluate and compare frailty measures over time. As such, the study remains underpowered to definitively change current practice but provides critical observations to consider in managing and studying frail patients. Additionally, these acutely injured patients included groups who sustained a traumatic injury, required emergency surgery, or sustained burn injury. While each acute injury subset may each yield unique correlations or behavior with regard to frailty identification and behavior, our analysis of injury type subsets did not yield any correlation with frailty, probably due to the small sample size of our study and correspondingly of each subset. Given the diversity of injury, each pathologic process may individually affect frailty over time differently and must be considered in a future study. Furthermore, delirium remains a major risk factor in the elderly population in general and has been identified as having a significant association with frailty.[10] Although the TSFI considers the degree of dementia in its determination of frailty, most scoring systems either do not or indirectly address the impact that delirium has on frailty assessment and management. Additionally, in our study, TSFI had the most significant changes in frailty scoring over time, which may make it an ideal frailty scoring system to consider for long term assessment. The fact that it incorporates 15 variables compared to the smaller number of variables in the other two scoring systems used in this study may be an unfair comparison. Utilizing scoring systems with a closer number of variables to consider may be a more appropriate comparison. Finally, we did not assess the place of dwelling on follow up surveys so we are unable to know how patient independence changed over the study period.

Conclusions

In conclusion, the risk of falls postdischarge was associated with age, time postdischarge, and frailty in our population. With all frailty scoring systems studied, an increase in frailty was associated with an increase in the odds of a fall. The highest AUC estimates for falls were observed for the TSFI. Different scales showed different specificities and sensitivities, possibly making different scales useful in different scenarios such as screening *versus* testing. Future studies on larger populations are warranted to confirm the usefulness of these frailty scoring systems.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgment

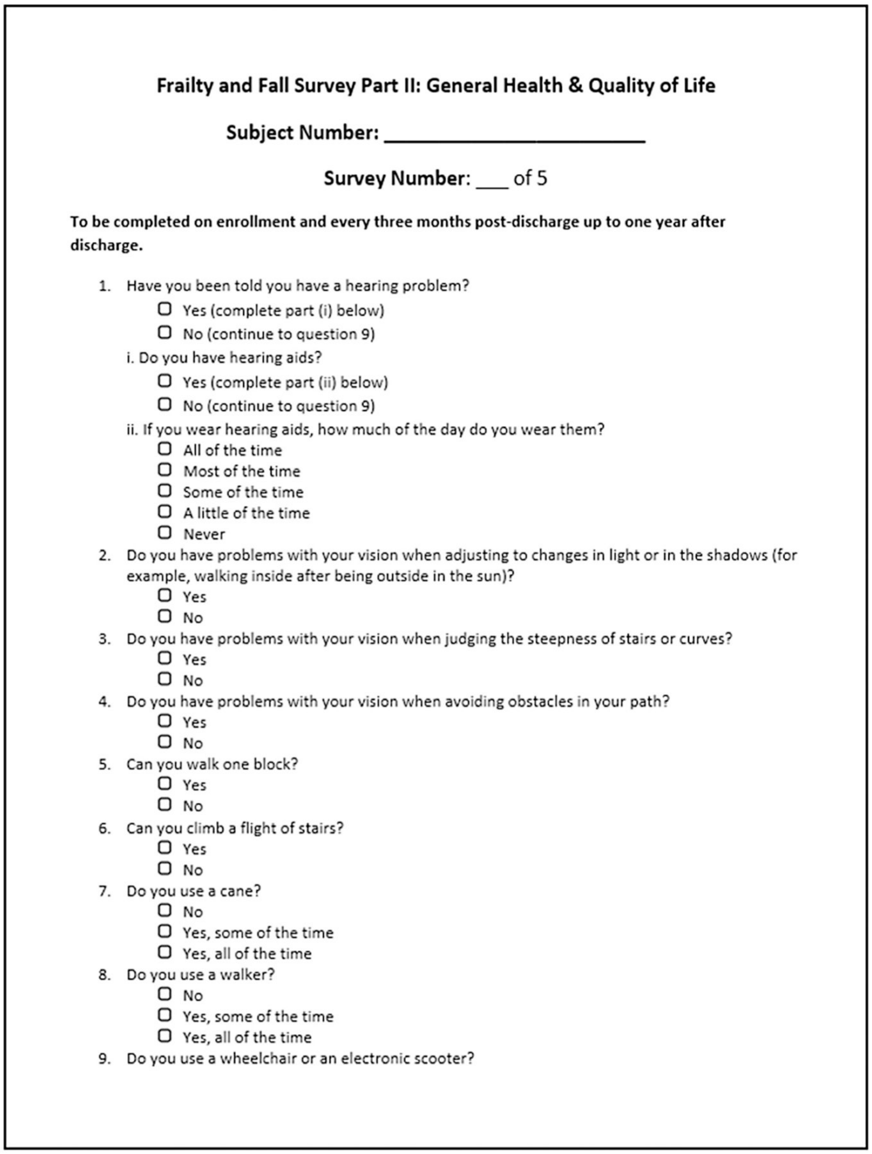
We thank Ella Born for assisting with follow up phone calls to participants.

Funding: This research was supported by the University of Iowa Injury Prevention Research Center and funded in part by grant #R49 CE002108-05 of the National Center for Injury Prevention and Control/CDC. This project was further supported by the National Center for Advancing Translational Sciences, National Institutes of Health, through grant award numbers UL1TR001860 and UL1TR002537. The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH.

REFERENCES

1. Hatcher VH, Galet C, Lilienthal M, Skeete DA, Romanowski KS. Association of clinical frailty scores with hospital readmission for falls after index admission for trauma-related injury. JAMA Netw Open. 2019;2:e1912409. [PubMed: 31577357]
2. Werner CA. The older population, 2010. Washington, D.C: U.S. Department of Commerce, Economics and Statistics Administration, U.S. Census Bureau; 2011.
3. Curtis E, Romanowski K, Sen S, Hill A, Cocanour C. Frailty score on admission predicts mortality and discharge disposition in elderly trauma patients over the age of 65 y. J Surg Res. 2018;230:13–19. [PubMed: 30100028]
4. Trampisch U, Moschny A, Platen P, Klaaßen-Mielke R, Hinrichs T. Barriers to physical activity in older adults in Germany: a cross-sectional study. Int J Behav Nutr Phys Act. 2011;8:121. [PubMed: 22047024]
5. Rasinaho M, Hirvensalo M, Leinonen R, Lintunen T, Rantanen T. Motives for and barriers to physical activity among older adults with mobility limitations. J Aging Phys Act. 2007;15:90. [PubMed: 17387231]

6. Gillespie LD, Robertson MC, Gillespie WJ, et al. Interventions for preventing falls in older people living in the community. Cochrane Database Syst Rev. 2012:CD007146. [PubMed: 22972103]
7. Stevens JA, Ballesteros MF, Mack KA, Rudd RA, DeCaro E, Adler G. Gender differences in seeking care for falls in the aged Medicare population. Am J Prev Med. 2012;43:59–62. [PubMed: 22704747]
8. Maxwell CA, Patel MB, Suarez-Rodriguez LC, Miller RS. Frailty and prognostication in geriatric surgery and trauma. Clin Geriatr Med. 2019;35:13–26. [PubMed: 30390979]
9. Ritt M, Bollheimer LC, Sieber CC, Gaßmann KG. Prediction of one-year mortality by five different frailty instruments: a comparative study in hospitalized geriatric patients. Arch Gerontol Geriatr. 2016;66:66–72. [PubMed: 27259029]
10. Persico I, Cesari M, Morandi A, et al. Frailty and delirium in older adults: a systematic review and meta-analysis of the literature. J Am Geriatr Soc. 2018;66:2022–2030. [PubMed: 30238970]
11. Galet C, Zhou Y, Eyck PT, Romanowski KS. Fall injuries, associated deaths, and 30-day readmission for subsequent falls are increasing in the elderly US population: a query of the WHO mortality database and National Readmission Database from 2010 to 2014. Clin Epidemiol. 2018;10:1627–1637. [PubMed: 30519111]
12. Clegg A, Young J. The frailty syndrome. Clin Med (Lond). 2011;11:72–75. [PubMed: 21404792]
13. Lang P-O, Michel J-P, Zekry D. Frailty syndrome: a transitional state in a dynamic process. Gerontol Gerontol. 2009;55:539–549.
14. Morley JE, Vellas B, van Kan GA, et al. Frailty consensus: a call to action. J Am Med Dir Assoc. 2013;14:392–397. [PubMed: 23764209]
15. Joseph B, Hassan A, Pandit V. Frailty in trauma: a systematic review of the surgical literature for clinical assessment tools. J Trauma Acute Care Surg. 2016;81:805.
16. Maxwell CA, Mion LC, Mukherjee K, et al. Preinjury physical frailty and cognitive impairment among geriatric trauma patients determine postinjury functional recovery and survival. J Trauma Acute Care Surg. 2016;80:195–203. [PubMed: 26595712]
17. Gardiner PA, Mishra GD, Dobson AJ. Validity and responsiveness of the FRAIL scale in a longitudinal cohort study of older Australian women. J Am Med Dir Assoc. 2015;16:781–783. [PubMed: 26089117]
18. Morley JE, Malmstrom TK, Miller DK. A simple frailty questionnaire (FRAIL) predicts outcomes in middle aged African Americans. J Nutr Health Aging. 2012;16:601–608. [PubMed: 22836700]
19. Hyde Z, Flicker L, Almeida OP, et al. Low free Testosterone predicts frailty in older men: the health in men study. J Clin Endocrinol Metab. 2010;95:3165. [PubMed: 20410223]
20. Joseph B, Pandit V, Zangbar B, et al. Validating trauma-specific frailty index for geriatric trauma patients: a prospective analysis. J Am Coll Surg. 2014;219:10–17.e1. [PubMed: 24952434]
21. Rockwood K, Song X, MacKnight C, et al. A global clinical measure of fitness and frailty in elderly people. CMAJ. 2005;173:489–495. [PubMed: 16129869]
22. Akaike H New Look at statistical-model identification. IEEE Trans Automatic Control. 1974;Ac19:716–723.
23. Akkaike H Information theory and an extension of the maximum likelihood principle In: Petrov BN, Csaki F, eds. 2nd International Symposium on Information Theory (Akademia Kiado, Vudapest). 1973:267–281.
24. Maxwell D, Rhee P, Drake M, Hodge J, Ingram W, Williams R. Development of the Burn Frailty Index: a prognostication index for elderly patients sustaining burn injuries. Am J Surg. 2019;218:87–94. [PubMed: 30477759]
25. Hamidi M, Zeeshan M, Leon-Risemberg V, et al. Frailty as a prognostic factor for the critically ill older adult trauma patients. Am J Surg. 2019;218:484–489. [PubMed: 30833015]
26. McDonald VS, Thompson KA, Lewis PR, Sise CB, Sise MJ, Shackford SR. Frailty in trauma: a systematic review of the surgical literature for clinical assessment tools. J Trauma Acute Care Surg. 2016;80:824–834. [PubMed: 26881488]
27. Bryant EA, Tulebaev S, Castillo-Angeles M, et al. Frailty identification and care pathway: an interdisciplinary approach to care for older trauma patients. J Am Coll Surg. 2019;228:852–859.e1. [PubMed: 30959106]



Frailty and Fall Survey Part II: General Health & Quality of Life

Subject Number: _______________________

Survey Number: ___ of 5

To be completed on enrollment and every three months post-discharge up to one year after discharge.

1. Have you been told you have a hearing problem?
   - ☐ Yes (complete part (i) below)
   - ☐ No (continue to question 9)

   i. Do you have hearing aids?
   - ☐ Yes (complete part (ii) below)
   - ☐ No (continue to question 9)

   ii. If you wear hearing aids, how much of the day do you wear them?
   - ☐ All of the time
   - ☐ Most of the time
   - ☐ Some of the time
   - ☐ A little of the time
   - ☐ Never
2. Do you have problems with your vision when adjusting to changes in light or in the shadows (for example, walking inside after being outside in the sun)?
   - ☐ Yes
   - ☐ No
3. Do you have problems with your vision when judging the steepness of stairs or curves?
   - ☐ Yes
   - ☐ No
4. Do you have problems with your vision when avoiding obstacles in your path?
   - ☐ Yes
   - ☐ No
5. Can you walk one block?
   - ☐ Yes
   - ☐ No
6. Can you climb a flight of stairs?
   - ☐ Yes
   - ☐ No
7. Do you use a cane?
   - ☐ No
   - ☐ Yes, some of the time
   - ☐ Yes, all of the time
8. Do you use a walker?
   - ☐ No
   - ☐ Yes, some of the time
   - ☐ Yes, all of the time
9. Do you use a wheelchair or an electronic scooter?

Fig –.

Representative first page image of the survey administered to the patients at enrollment and at regular intervals for 1 y.

Table 1 –

Patient demographics.

Demographics	Statistics
Age (median; range)	74 (65–96)
Female (*N*; %)	29 (51.8)
Caucasian (%)	57 (98.3)
BMI (median; range)	28.2 (22.9–52.7)
Admission GCS	15 (11–15)
Hospital LOS (median; range)	4.5 (1–41)
ICU LOS	0 (0–15)
Mortality Rate (*N*; %)	9 (15.5)
Past medical history	
Cardiovascular disease (*N*; %)	39 (67.2)
Cancer (*N*; %)	14 (24.1)
Diabetes (*N*; %)	14 (24.1)
Lung disease (*N*; %)	9 (15.5)
Osteoporosis (*N*; %)	8 (13.8)
Arthritis (*N*; %)	7 (12.1)
Depression (*N*; %)	7 (12.1)
Stroke (*N*; %)	6 (10.3)
Generalized Anxiety Disorder (*N*; %)	5 (8.62)
Substance use Disorder (*N*; %)	3 (5.17)
Parkinson’s Disease (*N*; %)	2 (3.45)
Dementia (*N*; %)	1 (1.72)
Trauma surgery service (*N*; %)	31 (53.4)
Emergency general surgery service (*N*; %)	19 (33.8)
Burn surgery service (*N*; %)	8 (13.8)
Admission FRAIL scale score (median; range)	1 (0–4)
Admission TSFI score (median; range)	0.18 (0.1–0.67)
Admission CSHA-CFS score (median; range)	4 (2–7)
Frail patients by FRAIL scale (*N*; %)	10 (18.5)
Frail patients by TSFI (*N*; %)	18 (33.3)
Frail patients by CSHA-CFS (*N*; %)	18 (33.3)

BMI = body mass index; ISS = injury severity score; LOS = length of stay.

Table 2 –

Sensitivity and specificity of each frailty scale to predict mortality and falls.

Frailty score	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Mortality				
FRAIL scale	25	82.6	20	86.4
CSHA-CFS	50	69.6	22.2	88.9
TSFI	50	69.6	22.2	88.9
Falls				
FRAIL scale	29.2	90	70	61.4
CSHA-CFS	41.7	73.3	55.6	61.1
TSFI	45.8	76.7	61.1	63.9

Table 3 –

Factors associated with falls. Results of logistic regression relating changes in log odds of a fall to time (week), patient age, and frailty scores measured using each frailty scoring system. Age was centered at 65.

Parameter	Estimate	Standard error	95% confidence limit		Z	*P* value
FRAIL scale	0.64	0.18	0.29	0.98	3.62	<0.01
TSFI	7.40	1.55	4.36	10.43	4.78	<0.01
CSHA-CFS	0.87	0.22	0.44	1.29	4.00	<0.01