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Predicting 1-year disability and mortality of injured older adults

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ABSTRACT

Purpose: The growing incidence of elderly patients injured from falls, combined with a growing understanding of the contribution of cognition and frailty to mortality, prompted this work. Our objective was to develop a clinical risk prediction model for prognosticating disability and mortality among injured older adults 1 year after hospitalization.

Methods: Secondary analysis of prospective longitudinal data from an urban Level 1 trauma center. A proportional odds regression model was used to model mortality and functional status as ordinal outcomes. Death was treated as the lowest functional status, and 3 ordered groups of the Barthel Index were treated as higher functional status. 188 patients aged 65 and older who were admitted through the emergency department from 2013 to 2014 with a primary injury diagnosis comprised the prospective cohort. Follow-up assessments were performed at 30-days, 90-days, 6-months, and 1-year. Predictors in the model included: baseline physical function, baseline cognition, two physical frailty measures, age, injury severity, a comorbidity index, gender, living location, mechanism of injury, and hospital admitting service.

Results: The full model yielded an R^2 of 0.45, and Life Space Assessment, Vulnerable Elders Survey, and Injury Severity were the most influential predictors. Approximated models (to encourage clinical use) yielded an R^2 of 0.86. Calibration assessment (i.e., accuracy) demonstrated a mean squared error < 0.003 at all 3 intercepts.

Conclusions: A moderate statistical signal was discovered that contributed to a highly accurate clinical prediction model. Approximated models and nomograms could be used by clinicians, patients, and families in shared decision making during hospitalization.

1. Introduction

The relevance of frailty and cognitive decline in clinical aging research is of increasing importance. As individuals age, the body's ability to maintain homeostasis after a stressful event (i.e., injury) declines as frailty develops. (Clegg, Young, Iliffe, Rikkert, & Rockwood, 2013) Recent studies highlight the importance of cognitive frailty (Montero-Odasso, Barnes, & Speechley, 2016; Panza, Seripa, & Solfrizzi, 2015; Panza, Solfrizzi, & Barulli, 2015) and frailty trajectories (Whitson et al., 2016; Todd & Clegg, 2016; Chamberlain, Finney Rutten, & Manemann, 2016) for identifying subclinical stages and earlier targeting of interventions. (Chamberlain et al., 2016) The influence of these characteristics on outcomes among injured older adults (geriatric trauma) was reported in a study at our level one trauma center where we examined the role of physical frailty and cognitive decline in a prospective longitudinal cohort. (Maxwell, Mion, & Mukherjee, 2016) Previous work indicates up to 33% of hospitalized injured older adults are discharged to a skilled nursing facility, (Davidson et al., 2011) over 50% experience functional decline, and 25% die within one year after injury. (Hashmi, Ibrahim-Zada, & Rhee, 2014)

Given these recent findings, clinically useful prediction models could provide a means for identifying patients on a "frailty" continuum and subsequently facilitate identification before frailty ensues and facilitate patient and family communication during hospitalization. Furthermore, such models may provide clinicians, patients, and families with information to aid decision-making regarding an increase in physical activity and/or utilization of community resources, post-discharge placement, rehabilitation choices and advance care planning. The purpose of the work described here was to develop a clinically useful prediction tool for providers who care for injured older adults. The model is based on a prospective cohort study we previously conducted with primary findings published elsewhere. (Maxwell et al.,

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2016) To our knowledge, there are no practical risk prediction models that address baseline (pre-injury) cognition and frailty in the geriatric trauma population.

2. Methods

The content of this paper is intended to meet manuscript inclusion criteria and recommendations of the Critical Appraisal and Data Extraction for Systematic Review of Predictions Modeling Studies: The CHARMS Checklist. (Moons, de Groot, & Bouwmeester, 2014) Approval for the study was obtained from the Vanderbilt University Institutional Review Board (#130992).

2.1. Sample and setting

The sample used in the development of the model came from a prospective cohort study of 188 patients aged 65 and older who were admitted through the emergency department with a primary injury diagnosis. The study took place at Vanderbilt University Medical Center, a level I trauma center. Participants were recruited from three services (trauma, geriatrics, orthopedics) within 48 h of hospital admission via face-to-face interviews with patients and/or surrogate respondents, and patients were enrolled from October 2013 through March 2014. Non-English-speaking patients were excluded. Inclusion criteria required the availability of a surrogate respondent. One of six trained research assistants (RA) or the PI (CAM) interviewed each older adult and his or her proxy on the same day as enrollment.

2.2. Instruments and measures

Selection of instruments was based on the potential for future use by bedside clinicians using the following criteria: administration time ≤5 min, psychometric properties established in older populations, availability at no cost, use in inpatient settings, and usable with both patients and surrogate respondents.

2.2.1. Functional capacity

The Vulnerable Elders Survey (VES-13) is a 13-item instrument that assigns points to four categories: age, self-rated health, common physical tasks, and activities of daily living (ADLs). Scores ranges from 0 to 10, and the VES-13 has a sensitivity of 67% to 87% and specificity of 62% to 86% for identifying impairments identified through comprehensive geriatric assessment. (Smets et al., 2014 ; Biganzoli, Boni, & Becheri, 2013; Luciani, Ascione, & Bertuzzi, 2010; Mohile, Bylow, & Dale, 2007) The Barthel Index is a 10-item instrument that assesses 10 ADLs on a scale that ranges from 0 to 20, with a score of 20 indicating no disability and lower scores indicating increasing levels of ADL deficits. (Collin, Wade, Davies, & Horne, 1988) The Life Space Assessment (LSA) assesses patterns of mobility during the month preceding assessment. (Baker, Bodner, & Allman, 2003) Five questions (one for each life space) contain three parts: movement (yes/no) in the space, frequency of movement within the space, and level of independence. A score is calculated for each life space by multiplying the three parts. A total score is derived by summing the scores for each of the five life spaces (range: 0–120).

2.2.2. Cognition

The AD8 Dementia screen is an eight-item instrument that differentiates normal cognitive aging from mild dementia. (Galvin, Roe, & Powlishta, 2005) The AD8 includes eight (yes/no) items related to memory and thinking with scores ranging from 0 to 8. A cutoff of 2 or greater indicates likely cognitive impairment. The short Informant Questionnaire on Cognitive Decline in the Elderly (IQCDE) is a 16-item instrument, administered to surrogates who have been closely acquainted with the patient. (Jorm, 2004) Each item compares current factors related to memory and intelligence to the same factors 10 years prior. Patients are rated on a Likert scale (1–5) from “much improved” (1) to “much worse” (5).

Table 1
Baseline characteristics (during hospitalization) of participants who completed study or died (n = 176).

Variable Name	Median	IQR	Range	N(%)	d.f. in full model
Barthel	19	17–20	3–20		2
Vulnerable Elders	4	1–7	0–10		2
Life Space Assess.	56.5	33–80	3–120		2
AD8 Dementia	1	0–4	0–8		2
IQCDE	3.2	3.0–3.7	2.9–5.0		n/a
Comorbidity Index	3	0–8	−7 to 27		1
Injury Severity	10	9–17	0–38		1
Age (years)	77.5	70–86	65–101		n/a
Gender (Female)				102 (58)	p.c.
Surrogate					n/a
Child				97 (55)	
Spouse				58 (33)	
Other				21 (12)	
Admitting Service					p.c.
Trauma				134 (76)	
Orthopedics				26 (15)	
Geriatrics				16 (9)	
Living Location					p.c.
House/Apartment				157 (89)	
Assisted Living				13 (7)	
SNF				6 (3)	
Mechanism of Injury					p.c.
Fall				120 (68)	
Motor Vehicle				44 (25)	
Other				12 (7)	

Note: SNF = skilled nursing facility; d.f. = degrees of freedom; n/a = not included in model; p.c. = principal component. Age was not included in the full model because the Vulnerable Elders Survey already includes age.

2.2.3. Other

Upon discharge from the hospital, other variables, including comorbidities, injury severity and discharge disposition were obtained from the medical record. Comorbidities were derived from ICD-9 codes and categorized according to the Elixhauser comorbidity classification system. Point values were assigned to comorbidities based on van Walraven et al., (van Walraven, Austin, Jennings, Quan, & Forster, 2009) who identified independent associations of comorbidities with mortality. Injury severity scores were calculated according to the American Association for Automotive Medicine Abbreviated Injury Scale. (Gennarelli & Wodzin, 2008)

2.3. Data collection procedures

Research assistants received 8 h of training in enrollment and instrument administration. All RAs were registered nurses. Practice screening was conducted in the hospital until interrater agreement with the PI reached a 95% level. Enrollment and initial screening occurred over a 6-month period. RAs determined patient eligibility before approaching patients and/or surrogates for enrollment. A surrogate was defined as a person who had known the patient for at least 5 years and who lived with the patient or spent at least 4 h per week with the patient. Patients were excluded from the study if a surrogate was not available for screening within 48 h after admission. Surrogates were interviewed in a location separate from the patients. Patients and surrogates were asked to answer questions based on the patient’s preinjury status, defined as 2 weeks preceding the causal injury for admission. Demographic data were obtained from respondents, followed by administration of the five screening instruments.

Follow-up phone call assessments were made to either the patient or surrogate at 30-days, 90-days, 6-months, and 1-year, and all screening instruments were re-administered with responses based on the patient’s