Ambulatory assisted living fallers at greatest risk for head injury

Characteristics of elderly fallers in long term care at greatest risk for head injury

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Running Head: ELDERLY FALLERS AT GREATEST RISK FOR HEAD INJURY

Abstract

OBJECTIVES: To determine the relationship between head injuries sustained during each fall with various known high risk health and demographic factors predictive of falls.

DESIGN: Prospective cohort study conducted over 1 year

SETTING: Assisted living and skilled nursing units of a Continuing Care Retirement Community located in the northeastern United States.

PARTICIPANTS: Sixty nine OAs who fell.

MEASUREMENTS: Age, gender, diagnosis, high risk medication, functional, cognitive, ambulation/elimination status, mode of locomotion, fall related symptoms and the position of the fall, were analyzed using General Estimating Equations among elderly fallers with and without head injury.

RESULTS: A total of 173 falls (average of 2.9 times) were observed for 62 patients who had complete injury data. Injuries were recorded in 40.5% of falls, with 41.4% being head injuries. Head injuries were more likely to be hematomas than lacerations (66.7% vs. 14.7%) and among assisted living residents (p=0.04). Head injured patients were more likely to be walking at the time of the fall (69% vs. 36.1%) and less likely to have bowel incontinence (3.5% vs. 28.5%; p=0.04). None of the high risk diagnosis or medications associated with falls risk increased risk for head injury.

CONCLUSION: Those at greatest risk for head injury were ambulatory assisted living residents. None of the known clinical conditions predictive of risk to fall were predictive of head injury. For head injury prevention to be successful we need a closer examination of resident's mobility, shoe-wear, health behavior with respect to ability to use assistive devices, and floor

surface landing area. Future health policy implications include measures to ensure standard of care practices for head injured patients are in place.

Key words: head injury, post-fall, assisted living, skilled nursing

INTRODUCTION

Falls are a leading cause of traumatic brain injury (TBI) especially for persons aged 75 and older, noted to have the highest rates of TBI-related hospitalization and deaths in the United States (US)[1,2]. Over sixty percent of all TBI injuries among older adults occur from falls[2]. While TBI severity runs the gamut from "mild forms with changes in mental status to more severe penetrating head injuries[2]" very little is known about head injury incidence, type and outcomes in long-term care where some 1.5 million elders reside[3] and experience recurrent falls[4,5,6]. Moreover, although the pioneering work of researchers in aging has provided evidence about fall etiology, [4, 7, 8] risk to fall and associated risk for serious injury[9-25] less explored are clinical characteristics, circumstances and outcomes of elderly long-term care residents at greatest risk for head injury. Serious outcomes of head injury include TBI-related deaths[26] and avoidable emergency department visits[27] as well as subdural hematoma. Across the United States, fall-related injuries rank as the 8th leading cause of death [28] and are the most common condition associated with potentially preventable emergency department visits by nursing home (NH) residents[27].

Ensuring patient safety among elders at risk for serious injury is a fundamental aim of healthcare providers and expectation of patients- and one which requires close examination of identifying demographic, clinical and circumstantial risk factors for head injury. If we can modify, lessen or prevent falls and associated head injury we will be one step closer to reducing morbidity and mortality associated with traumatic falls in this most vulnerable population.

The prevention of head injuries among elderly fallers is a public health priority given the large numbers of older NH residents who fall and the aftermath injurious falls has on quality of life, morbidity,

77 mortality and hospitalization rates[1,2,26-28]. Yet very little evidence exists about incidence, risk factors and
78 outcomes of elderly NH residents with post-fall head injury. In our background search to determine
79 the nature and incidence of elderly fallers with head injury in NHs, a ten year literature search
80 using text words: head injuries, accidental falls and NHs produced only six articles, none of
81 which were relevant to our understanding of post fall head injuries in the NH setting.

82 Given the limited empirical evidence of head injury in elderly NH fallers, we thought it
83 important to identify if known high-risk co-morbidities, medications and circumstances linked to
84 falls occurred more often among those with head injury. Co-morbidities included in this study
85 were: dementia, Parkinson's Disease (PD), Diabetes Mellitus (DM), chronic obstructive
86 pulmonary disease (COPD), incontinence of bladder and bowel, coronary artery disease (CAD)
87 and atrial fibrillation (AF). Dementia and associated white matter disease and visual spatial
88 impairment is an independent risk for falling[29], and for sustaining future injurious falls[30].
89 Dementia, a progressive disease which causes a loss of recent memory and lack of awareness of
90 prior falls or even head injury, has been well documented in elders[31]. PD produces postural
91 instability with associated symptoms of loss of balance leading to falls risk[32]. Elderly diabetic
92 women have increased falls risk due to complications of postural instability, autonomic
93 neuropathy and/or hypoglycemia[33-34]. COPD has been associated with balance impairment[35] and
94 evidence substantiates urinary incontinence, either urge[36-38] or mixed etiology[39] with increased
95 falls risk. Although there is little empiric research, clinical observation of older adults with
96 coronary artery disease indicate oxygen deprivation may play a role in falls. During exertional
97 activity such as walking, persons with CAD may experience impairment in oxygenation and thus
98 have higher risk to fall. Similarly elderly patients with cardiac rhythm disturbances may fall
99 should hypotension or rhythm abnormalities develop.

Medications have long been recognized as major contributors to falls in older adults[19-20]. Besides the absolute number of medications, medication classification is relevant. Beta blockers and diuretics, both capable of producing hypotension and urinary incontinence have a significant role in increasing fall risk in elderly patients[20, 40]. Evidence also substantiates the risk of brain injury resulting in intracranial hemorrhage due to falls for patients taking anti-platelet agents such as Aspirin or clopidogrel[41]. Long term anticoagulation use is independently associated with traumatic intracranial hemorrhage and subsequent mortality in elderly patients hospitalized for falls[42].

In addition to the type of chronic condition and medications taken by elderly NH fallers, the mobility status and position from which the fall occurred has relevance to the production of head injury post-fall. Fall-related injuries are quantified by severity according to the height, among others, from which the body has fallen to the ground. Important information for future study can be learned from inclusion of the resident's position at the time of the fall: for instance were they walking, lying on the bed, sitting, transferring, or attempting to stand? Current indices, as the Injury Severity Score (ISS) have shown fall height to be significantly associated with the extent of the injury and ISSs[43, 44]. Head injuries have been noted among falls from up to 7 meters and beyond 30 meters[45]. Moreover, evidence shows elderly persons over age 70 who fall from a standing position to the ground (e.g., "ground-level" falls) are 3 times more likely to die than those under age 70[46], and up to 35% of injurious falls including head injury have been by non-ambulatory residents[47] .

While elderly NH residents possess many circulatory and cognitive disorders, take multiple high-risk medications to manage these conditions, possess various patterns of mobility, and fall from various heights, we do not know which, if any of these factors increase risk of head

injury. Research questions guiding this study include: 1) among a cohort of elderly NH fallers, how many experienced head injury?; and 2) were there any differences in gender, age, co-morbidities, high-risk medications, risk to fall, functional and/or cognitive status among those with head injury versus those without?

METHODS

Study Design

This is a prospective cohort study of elderly NH residents (June 1, 2006-May 31, 2007) who participated in a 3year quality improvement study with a pre-test/post-test design. During the intervention year, a comprehensive post fall assessment tool (called the Post-Fall Index [PFI^{TM}]) was used by trained staff nurses facility-wide as part of the research protocol to improve the quality of the post-fall assessment and inform their clinical decision making for falls management. The data examined was derived by nurses using the PFI^{TM} for this cohort of elderly fallers. In previous research we have described the psychometric properties of the PFI^{TM}: a reliable, valid and feasible measure to comprehensively assess older adult residents' condition. A full description of the parent study and use in clinical practice is available[6, 48].

Setting

This study took place at a 110 bed continuing care retirement community (CCRC) in the northeastern United States. The CCRC has independent living sections and a healthcare facility comprised of a 51 bed assisted living (AL) unit and a 59 bed skilled nursing (SN) unit. This 3 year facility-wide study began on May 31, 2005 and ended on June 1, 2008. All residents over age 65 of the AL or SN unit were enrolled on a prospective basis during the intervention year if they sustained a fall, thus comprising the one year cohort sample of elderly fallers. Falls were counted if they were directly observed or if they were reported by the staff or the resident to occur at the CCRC. All participants over age 65 who fell had data collected through the PFI^{TM} obtained by trained nurses.

Participants

All residents who fell during the intervention year received the PFI™ and were included in the sample; groups were stratified as being exposed (fall with head injury) or unexposed (fall without head injury). There was 100 percent adherence to using the PFI™ post fall. The primary sample was 77 older adult residents who experienced a fall while residing on one either the AL or SN units of the CCRC. Among these fallers, a total of 173 falls occurred, of which 29 head injuries occurred (16.8% of the sample). 144 falls were without head injury (83.2% of the sample).

Ethical Considerations. Institutional Review Board (IRB) approval was granted by the University of Pennsylvania to conduct the study. All older adult residents (over age 65) and all family caregivers were provided a letter outlining the purpose and nature of the study, conditions for participation, risks and benefits and the research protocol. No family caregivers or residents refused to participate and no one withdrew. Because the study was facility-wide and the older adult residents received improved comprehensive post fall assessment, facility wide consent was granted by the Resident Council, Nursing and Medical Administration and Chief Executive Officer.

Efforts to reduce bias. All data collected by trained staff nurses were individually reviewed for completeness by the unit manager of the AL or SN unit and the Assistant Director of Nurses (ADON).

Variables

Outcome variables of interest were extrapolated from the PFI™ database which was completed within 24 hours of the resident's fall. Outcome variables of interest included: demographic, clinical characteristics of each resident, such as medical diagnoses, medication use, functional

and cognitive status, fall risk, total number of falls, time of day and fall circumstances, and injury post-fall. Co-morbidities and medication use were entered by trained nurses exactly as they appeared from the resident's medication administration record (MAR) for those exposed (fallers with head injury) and unexposed (fallers with no head injury) participants. Functional status related to locomotion and ambulation/elimination status and fall risk score were extrapolated by trained research assistants from the Minimum Data Set (MDS). Post fall treatment variables of interest were extrapolated from the PFI^{TM}. MMSE scores were obtained by the nurses from review of the medical record, noting MMSE scores within the past six months or from their own administration of a MMSE at the time of the fall. Research assistants verified the medical information provided on the nurses MAR or MDS to the electronic data housed for each resident in the central administration Office of Medical Records at the CCRC.

Demographic Characteristics. Age, defined in raw numbers at the time of the fall and gender, represented by male or female were extrapolated from the PFI database. Gender was noted as female or male. Ethnicity was noted as white, Hispanic, African American. Marital status was noted as single, married, widowed or divorced. The living arrangements of the fallers were noted to be in AL or SN units.

Clinical Characteristics. The clinical characteristics of the group of fallers who hit their heads and those who did not included: past medical history; medication use; fall risk; functional status (mode of locomotion and ambulation/elimination status); Mini-Mental State Examination (MMSE); position at the time of the fall; total number of falls; recurrent falls; total numbers and types of fall related injuries including head injuries.

Past medical history. Past medical history included: presence or absence of dementia, Parkinson's disease, diabetes mellitus, chronic obstructive lung disease, bladder/bowel incontinence, hypertension, coronary artery disease, myocardial infarction and atrial fibrillation. ***High-risk Medications.*** High risk medications of interest included use of aspirin products or blood thinners.

Locomotion. Mode of locomotion was subdivided to include: walks unassisted, uses cane/crutch or walker, wheels self in the wheelchair and/or wheelchair use as the main mode of locomotion. ***Ambulation/elimination.*** Ambulation/elimination status was noted to be: ambulatory/continent, ambulatory and incontinent.

Fall circumstances: Position at the time of the fall. The resident's ambulation status and position at the time of the fall was noted as: fall while walking, fall from bed, fall from chair, fall while sitting down, fall while standing up or bending over.

Post-fall treatment and head injury description. Post-fall treatments such as staying at the facility or transfer to the emergency room were noted as well as the type of injury-laceration or hematoma.

Fall risk status. Fall risk status was determined by the trained nurse using the Briggs Fall Risk Tool^{R}. The Briggs Fall Risk Tool provides a metric of the patient's risk status, rated as "high, low or no risk to fall" and is a gross measure used in the NH industry to assess risk to fall among all NH residents. Its categories include: cognitive status, ambulatory status, presence of high risk medications, and presence of chronic conditions, gait and balance. Scores greater than 10 indicate "high risk" status.

214 ***Cognitive Impairment***. The presence or absence of cognitive impairment was determined by
215 trained nursing staff using the Mini-Mental State Examination (MMSE; scores entered by the
216 staff nurse into the PFI database). Scores range from zero (0) to 30, with any score less than 24
217 suggestive of cognitive impairment.

218 ***Statistical Analysis***

219 The rate of falls, recurrent falls, injuries and head injuries was calculated based on the total and
220 recurrent number of falls experienced. Demographic and clinical characteristics of the sample
221 were calculated. Since a resident could experience more than one fall during the study period,
222 Generalized Estimating Equations (GEEs) were used. Analyses were conducted using SPSS
223 version 17.0 and Stata MP 11.2.

224

RESULTS

The results are divided into two tables, Table one presents the demographic characteristics of the sample of fallers while the clinical characteristics of elderly falls with and without head injury is presented in Table 2. 69 older adults comprised this cohort study, and experienced 173 falls during the one-year intervention period. Injury data was available and analyzed for 62 fallers, but missing for 7 individuals (see Table 1). Most fallers were female (77.4 %) and widowed (60%) with an average age of 89.7 years with an average between 2.5-2.9 falls per person (see Table 1). The vast majority of falls were recurrent, with 40% of the sample experiencing some sort of injury. There were a total of 29 head injuries, accounting for 41.4% of the sample. Both fallers with and without head injury tended to stay at the facility as only 7 of the 173 falls resulted in a transfer to the emergency department (see Table 2).

Among the clinical characteristics analyzed, elderly fallers without head injury were more likely to have bowel incontinence ($p=0.04$). Otherwise none of the chronic co-morbidities associated with falls risk were associated with a risk for head injury post-fall (see Table 2). Likewise, among known high risk medications associated with bleeding, neither use of aspirin or Plavix were more likely in the head injury group. Groups were similar in cognitive impairment, falls risk, ambulation/elimination status, use of assistive devices and presence of orthostatic hypotension at the time of the fall. Other important clinical findings implicated in falls such as level of alertness, lower extremity weakness, gait and balance impairment were not found to be associated with risk for head injury. Clinically relevant symptoms associated with elderly falls (see Table 2) such as leg weakness and loss of balance were more prevalent among those with head injury, but not of statistical significance ($p=0.36$). Other relevant physical examination findings such as ability to sit, stand and balance on initial standing were similar between groups.

Overall, fallers with head injuries (n=29) were more likely to reside in AL (p=0.04), to walk at the time of the fall (p=0.05) and to use a cane/crutch or walker at the time of the fall. Most injuries of the head were hematomas opposed to lacerations.

DISCUSSION

To our knowledge, this is the first cohort study in a CCRC to examine demographic and clinical characteristics among elderly fallers with or without head injury. Despite a few limitations several study findings warrant discussion.

First, of the 29 head injured patients, the great majority occurred in AL among ambulatory, cognitively impaired and at high risk to fall elders. Findings reinforce previous research showing ambulatory elders to be at the greatest risk to fall due to their upright mobility[4].

Second, of the 29 head injured patients, only 5 (17.2%) received medical evaluation at an emergency department despite having evidence of hematomas or lacerations of the head. Based on our current knowledge of head injury and TBI, transfer to the emergency department for head imaging was warranted. Failure to transfer for further medical evaluation could be interpreted as a violation of the standard of care, but we don't know if resident's refused transfer to the hospital or not. Because this study did not explore clinical decision making for post fall head injury care nor did it explore the physician orders or facility protocol to transfer head injury patients post fall to the emergency department for evaluation, we can't conclude this care was either negligent or inappropriate. More information would be helpful in future research studies aimed at including examination of intermediary variables such as refusal rates to transfer, rates of "do not hospitalize" orders, overall facility protocol for head injury or adherence to the Clinical Practice Guidelines. Specific individual level variables of interest would include: resident level of care, resident prognosis (terminally ill; grave) and resident choice for care before evaluation of the appropriateness of care provided to these head injured older adults can be formulated.

Third, the overall rate of falls (2.5-2.9) per resident is consistent with other reports of fall demography in this practice setting. As well, numbers of recurrent falls and fallers ranged upwards to 66.7% of the sample consistent with prior research[4]. While the percentage of overall total injuries was slightly higher than other reports, our incidence of 29 head injuries (per 173 falls; 16.8% of the sample) is consistent with other research reporting falls with serious injury to range between 3 to 35%[4].

Fourth, there were no co-morbidities or high risk medications for falls implicated to increase elders risk for head injury. The only situational circumstance, walking, at the time of the fall was shown to be of greater statistical significance for head injured patients. This finding has tremendous clinical implications for elders living in AL who are independently ambulating. Additional clinical research is warranted to evaluate older adult resident's ability to safely ambulate with or without an assistive device and to negotiate hazards in the environment.

Fifth, even though both groups had a high risk to fall, we don't know much about their risk to injure, which has its own set of outcomes and implications- such as greater morbidity and mortality and increased hospitalization. Unfortunately, while the Briggs Fall Risk Tool used in this study is a widespread metric for fall risk analysis, it does little to tell the clinician about risk to injure. If a risk to injure tool could be constructed, findings from this study suggest variables such as ambulation status and residence would be important inclusions. In addition the position at the time of the fall (sitting on a chair, bending over or standing) could be used to gauge distance to the lowest level and further construct mathematical models of risk to injure.

There are a few limitations of this study. First, both groups were cognitively impaired making resident recall of symptoms less reliable. Second this was a single site study of older adults from

one cohort, thus limiting generalizability. Third, for this sub-set of fallers with head injury, we do not have data to know whether or not these individuals used assistive devices for mobility while walking at the time of their fall, mainly because the data was drawn from 2 different datasets- the MAR and MDS data pertaining to mode of locomotion and ambulation/elimination status within the past 30 days and the PFI which presents data captured by the nurse at the time of the fall. Because ambulatory elderly NH residents trip over equipment or environmental obstacles, such as canes and walkers, it is important to discern if these devices were present during the fall or not. If residents did use a device while walking, inquiry about their judgment and ability to safely use the device would be needed in further analysis.

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Author Contributions:

DGM & SR designed study and responsible for manuscript preparation

DGM responsible for acquisition of subjects, interpretation of data and preparation of manuscript

SR & AT responsible for data analysis and interpretation

Sponsor's Role:

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Table 1. Demographic and Clinical Characteristics of the Sample of Fallers (n = 69)

	Injury data available (n = 62)	**Injury data missing (n = 7)**
Age at first fall	89.7 ± 7.1 (n = 52)	89.4 ± 6.1 (n = 4)
Female	48 (77.4)	5 (71.4)
Marital status at first fall:		
Married	13 (21.7)*	**
Divorced	4 (6.7)	
Widowed	36 (60.0)	
Single	6 (10.0)	
Unknown	1 (1.7)	
Number of falls	2.9 (1 – 11)	2.5 (1 – 6)
Number of recurrent falls	111 (64.2)	14 (66.7)
Number of recurrent fallers	38 (61.3)	4 (57.1)
Total number of injuries	70 (40.5)	NA
Total number of head injuries	29 (41.4)	NA
Description of Head Injury:		
Hematoma	20 (66.7)	NA
Laceration	5 (14.7)	

* - Data available for 60 patients only

** - No data available

Table 2. Clinical Characteristics of Falls (N = 173) with or without Head Injury

	Head injury	No head injury	p-value
n (%)	29 (16.8)	144 (83.2)	
First fall	9 (31.0)	53 (36.8)	0.59
Living arrangement:			
Assisted Living	24 (82.8)	69 (47.9)	0.04
Skilled nursing unit (low-skilled)	1 (3.5)	51 (35.4)	
Skilled nursing unit (high-skilled)	4 (13.8)	24 (16.7)	
Stayed at Facility	25 (86.2)	139 (96.5)	0.14
Emergency Department	5 (17.2)	2 (1.4)	*
Past Medical History:			
Dementia	13 (44.8)	80 (55.6)	0.89 **
Parkinson's Disease	1 (3.5)	12 (8.3)	0.38
Diabetes Mellitus	6 (20.7)	37 (25.7)	0.85
COPD	2 (6.9)	11 (7.6)	0.97
Bladder incontinence	13 (44.8)	76 (52.8)	0.92
Bowel incontinence	1 (3.5)	41 (28.5)	0.04
Hypertension	20 (69.0)	91 (63.2)	0.40
Coronary / MI / Angina	9 (31.0)	38 (26.4)	0.76
Atrial fibrillation	6 (20.7)	31 (21.5)	0.61
Dizziness with Head Turning	2 (6.9)	6 (4.2)	0.86
Leg Weakness:			
Left	7 (24.1)	29 (20.1)	0.65 **
Right	7 (24.1)	23 (16.0)	0.38

Level of consciousness:			
Lethargic	0 (0)	5 (3.5)	*
Alert	28 (96.6)	137 (95.1)	
Hyperalert	1 (3.5)	2 (1.4)	
Resident can sit	27 (93.1)	137 (95.1)	0.92
Resident can stand up	26 (89.7)	123 (85.4)	0.78
Balance steady on initial standing	15 (51.7)	49 (34.0)	0.14
Mode of locomotion in past week			
Walks unassisted	0 (0)	18 (12.5)	0.72
Uses cane/crutch/walker	22 (75.9)	77 (53.5)	
Wheels self in wheelchair	3 (10.3)	16 (11.1)	
Wheelchair is main mode	4 (13.8)	33 (22.9)	
MMSE:			
Prior to fall	23.1 ± 1.3 (n = 19)	23.2 ± 0.8 (n = 60)	0.77
At time of fall	19.8 ± 1.7	13.7 ± 1.0	0.12
Medications:			
Aspirin	8 (27.6)	25 (17.4)	0.67
Blood thinners (Plavix)	3 (10.3)	26 (18.1)	0.23
Ambulation/elimination status:			
Ambulatory/continent	14 (48.3)	50 (34.7)	0.34
Ambulatory/incontinent	13 (44.8)	56 (38.9)	
Chair-bound	2 (6.9)	38 (26.4)	
Normal gait	0 (0)	4 (2.8)	*

Uses assistive device	23 (79.3)	105 (72.9)	0.61
Fall Risk Status > 10	22 (75.9)	117 (81.3)	0.91
Position at time of fall:			
Walking	20 (69.0)	52 (36.1)	0.05 ***
Lying on bed	1 (3.5)	17 (11.8)	
Sitting on bed	2 (6.9)	6 (4.2)	
Standing, attempting to sit	1 (3.5)	21 (14.6)	
Sitting, attempting to stand	2 (6.9)	34 (23.6)	
Transferring	3 (10.3)	13 (9.0)	
Unknown	0 (0)	1 (0.7)	
Symptoms at the time of the Fall:			
Loss of balance	17 (58.6)	1 (0.7)	0.36 **
Lightheadedness	0 (0)	1 (0.7)	*
Dizziness	1 (3.5)	1 (0.7)	0.68
Fainting or blackout	1 (3.5)	1 (0.7)	0.40
Weakness on one side of body	0 (0)	1 (0.7)	*
Change in mental status	0 (0)	3 (2.1)	*
Orthostatic Hypotension at the time of the Fall (n = 107)			
Yes	1 (5.0)	15 (17.2)	0.43
No	18 (90.0)	66 (75.9)	
Near	1 (5.0)	6 (6.9)	

* - p-value unavailable due to sparse data

** - Multiple p-values are presented since patients can have multiple conditions

*** - For patients whose positions were known