



1 Characterization of fall patients: Does age matter?☆

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A B S T R A C T

Introduction: A fall can occur at any age, so determining fall characteristics is important for prevention programs. The aim was to characterize fall patients who presented to a trauma center. We hypothesized that fall characteristics and outcomes would vary with age. *Methods:* Fall patients during the period of January 1st, 2014–December 31st, 2015 were included. Data were retrospectively collected from the trauma registry and electronic medical records. Data were analyzed by Chi-square test with Yates' continuity correction and one-way ANOVA with Bonferroni's multiple comparisons test. *Results:* There were 1541 fall patients, 814 (52.8%) were male. Ages ranged from 11 months to 100 years. The admission rate was high at 86%, with an average hospital length of stay of 5.7 days. Patients in the 0–18 and 19–45 age groups spent significantly less time in the hospital ($p < 0.0001$). Elderly patients had the highest average injury severity score ($p < 0.0001$). However, the youngest patients required surgery more often ($p = 0.0004$). The overall mortality rate was 3.6% and 52.8% were male. The mortality rate increased with age, from 0% for the 0–18 age group to 6.9% for patients ≥ 65 years of age. Remarkably, fallers in the 19–45 and 46–64 age groups predominantly died from ground level falls even though the average fall height in these groups was the highest ($p < 0.0001$). More fallers in the 19–45 and 46–64 age groups tested positive for alcohol/drug use ($p < 0.0001$). Middle aged and elderly patients were more likely to be discharged to a skilled nursing or rehabilitation facility compared to younger patients who were discharged home. *Conclusions and practical applications:* Fall characteristics and outcomes varied with age. Data on age-specific characteristics and risk factors of falls will help in developing targeted interventions. Moreover, the association of fall characteristics with injuries and mortality may lead to better approaches to treat fall patients.

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Q8 1. Introduction

49 Falls are the leading cause of non-fatal injuries and remain a significant cause of morbidity and mortality in the United States (Centers for Disease Control and Prevention, n.d.-a). There are numerous risk factors that can contribute to a fall including poor vision, home environment, comorbidities, vigorous physical activity, medications, occupational hazards, osteoporosis, and lack of muscle strength (Dhital, Pey, & Stanford, 2010; Helgadottir, Laflamme, Monarrez-Espino, & Moller, 2014; Jacobs, 2016; Pfortmueller et al., 2014; Socias, Chaumont Menendez, Collins, & Simeonov, 2014). Every year millions of people are treated at trauma centers for fall related injuries, many of which require hospitalization and rehabilitation or long-term care. The cost of treating fall injuries is exponential, with billions of dollars being spent each year. The annual direct medical cost for treating fall injuries is 31

billion dollars, two thirds of which account for hospital costs (Burns, Stevens, & Lee, 2016). This is a concern for trauma centers, given that falls are the main mechanism of injury resulting in admission (American College of Surgeons, 2016).

Falls occur among all age groups; however, focus has been on the elderly population. It is estimated that one in four older adults fall each year, and one in five falls cause a serious injury (Centers for Disease Control and Prevention, n.d.-a). Each year, 2.8 million older adults are treated in emergency departments for fall injuries (Centers for Disease Control and Prevention, n.d.-a). Traumatic brain injuries and extremity/hip fractures are the most common injuries among the elderly (Gelbard et al., 2014; Harvey & Close, 2012; Rau et al., 2014). Over the past 10 years, the rate of unintentional fall deaths of older adults has increased to ~58% (Centers for Disease Control and Prevention, n.d.-a). Consequently, several studies have investigated falls in the elderly population. Elderly females fall more often and are more likely to fall indoors, while males are more likely to fall outdoors (Chippendale, Gentile, James, & Melnic, 2016; Kelsey et al., 2010). Due to frailty, elderly fallers also have a higher risk of a severe injury and a higher mortality rate (Alamgir, Muazzam, & Nasrullah, 2012; Ayoung-Chee et al., 2014; Demetriades et al., 2005).

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Studies have also investigated falls in children under 14 years of age. Falls are the leading cause of non-fatal injuries for children ages 0–18 years. Each day ~8000 children are treated in emergency rooms for fall related injuries (Centers for Disease Control and Prevention, n.d.-b). Falls in children occur both indoors and outdoors. Falls from furniture and stairs, or at playgrounds and school, or during recreational activities are common among younger fallers (Burrows et al., 2015; Fissel, Pattison, & Howard, 2005; Pomerantz, Gittelman, Hornung, & Husseinzadeh, 2012). Similar to elderly fallers, head injuries and fractures are the main injuries among children fallers (Bulut, Koksal, Korkmaz, Turan, & Ozguc, 2006; Burrows et al., 2015; Pomerantz et al., 2012). Fewer studies on falls in young and middle-age adults have been done, thus, less is known about this population of fallers. Talbot et al. reported that ambulation is the main cause of falls in middle-age fallers and injuries to the knee, ankle, hand, and wrist are the most common (Talbot, Musiol, Witham, & Metter, 2005). Other studies have also suggested that middle age adults have a lower hospitalization rate and mortality rate after a fall (Pfortmueller et al., 2014; Rau et al., 2014).

Although falls occur among all age groups, studies have concentrated on children and the elderly population. Fewer studies have investigated falls in young and middle-aged adults. In 2015, unintentional falls were the leading cause of nonfatal injury in the 25–64 age group (Centers for Disease Control and Prevention, 2015). At our trauma center, falls are the number one mechanism of injury each year and ~50% of fallers are in the 19–64 age range. In order to create better injury prevention programs, characterization of falls among all age groups was needed. A clear understanding of the risk factors and characteristics of falls for specific age groups will aid in developing more targeted interventions and may help to reduce the medical cost of treating falls. The aim of this retrospective study was to characterize fall patients who present to an urban, adult level one trauma center. We hypothesized that fall characteristics and outcomes would vary with age.

2. Methods

2.1. Study design and setting

This retrospective study included all trauma patients, during the period of January 1st, 2014 to December 31st, 2015, who presented to Jamaica Hospital Medical Center (JHMC), an urban, adult Level 1 trauma center in Queens, New York, after a fall. The trauma registry and electronic medical records were reviewed for demographics, fall characteristics, and clinical data. This study was approved by the Institutional Review Board, patient consent was not required.

Prior to arrival at a hospital, emergency medical services (EMS) may notify the hospital of their arrival depending on the mechanism of injury and the medical status of the injured person. Based on the reported mechanism of injury and physiological or anatomical criteria, the receiving hospital will activate a trauma notification. This trauma activation within the hospital will initiate the assembly of a team of medical personnel before the arrival of the injured patient.

This study was performed at an adult Level 1 trauma center where there are three tiers of trauma activations, with the urgency and severity increasing from tier 3 to tier 1. For falls not categorized as trauma activations, a consultation by other surgical specialties (Orthopedics, Neurosurgery, Thoracic, etc.) may be needed depending on the injury. Tier 3 falls have the lowest urgency and injury severity; they require a trauma consult within 30 min of an injury being identified by an emergency medicine physician. Falls are categorized as tier 2 activations if they are from a height of >20 ft for adults, or > 10 ft for children, or 3 × the height of the faller, or from any height if the faller is on anticoagulation medications. In addition to the mechanism of injury criteria for Tier 2 activations, Tier 1 activations require fallers to have poor vital signs, an open/depressed skull fracture, paralysis or suspected spinal cord injury, unstable pelvic fracture, two or more proximal long bone fractures, or a

penetrating injury to the head, neck, torso, or extremities proximal to the elbow/knee.

2.2. Geographic population

JHMC currently services over 1.2 million residents in Queens and Eastern Brooklyn in New York City (NYC). Three of the neighborhoods served by JHMC are designated as medically underserved areas by the Health Resources and Services Administration. Additionally, data from NYC Department of Health and Mental Hygiene indicate that ~25% of the residents in our service area are uninsured (New York City Department of Health and Mental Hygiene, 2015). A considerable percentage is also foreign born and have a weighted average household income of \$59,364 (Population Studies Center, 2013; United States Census Bureau, 2015). Over 52% of the service area is female, and most of the population identify as racial/ethnic minority residents. In JHMC's service area, almost one in three people is under the age of 20 years (New York City Department of Health and Mental Hygiene, 2010). The racial/ethnic characteristics of neighborhoods in JHMC's primary service area are as follows:

Neighborhood	White (%)	Black (%)	Hispanic (%)	Asian (%)
1	23	12	33	20
2	7	54	18	15
3	2	51	39	5

NYC Department of Health and Mental Hygiene. EpiQuery. NYC DOHMH Census Counts 2010.

2.3. Inclusion/exclusion

To capture patients who potentially sustained injuries, all trauma activation patients whose mechanism of injury was identified as a fall were included in the study. Patients who did not meet criteria for trauma activation but had a surgical consultation were also included. Patients were excluded if the fall was secondary to a medical condition such as cardiac arrest or stroke or other mechanism, such as being struck by a motor vehicle.

2.4. Variables collected

The trauma registry and electronic medical records were utilized to collect several variables. Variables collected included: gender, race/ethnicity, body mass index (BMI), alcohol/drug use, anticoagulation medications, fall height, fall location, time of fall, fall characteristics, hospital length of stay, intensive care (ICU) length of stay, intubation, surgeries performed, mortality, discharge location, injury severity score (ISS), injuries to specific body regions. An injury severity score (ISS) is assigned to each patient based on the injuries sustained; ISS can range from 0 to 75 depending on the complexity of the injuries. A patient with a score of 75 is fatally injured, while a patient with a score of 0 has no injuries.

2.5. Definitions

- Fall inadvertently coming to rest on the ground or other lower level.
- Indoor fall a fall that occurred inside a residential dwelling or non-residential building.
- Outdoor fall a fall that occurred outside a dwelling or building, including the driveway/yard and the street.
- Alcohol use a blood alcohol level above 0.01.
- Drug use a positive drug test for illegal drugs such as opiate, cocaine, marijuana, benzodiazepines.
- Intubation a process of placing a plastic tube through the mouth down into the trachea (windpipe). This is done to

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