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Research Article

Epidemiology of Open Globe Injuries Associated with Accidental Falls in the Older Population (Ages 65-89)

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Abstract

Falls are a common cause of morbidity and mortality in older adults 65-years and over with 1 in 20 cases involving the eye. Open globe injury, the most severe form of ocular was seen in approximately 3000 older adults (over 65-years) hospitalized for fall-related trauma over a 7-year period, between 2007 and 2014 using the National Trauma Data Bank (NTDB). Most patients were women (60.3%), White (79.4%), and were injured at home (64.4%). Blood alcohol levels were above the legal limit in 5.1% of cases, and 2.3% reported use of illicit drugs. An underlying diagnosis of dementia was documented in 4.5% patients, and 3.5% were thought to be functionally dependent. One in 4 cases required ICU admission due to concurrent severe systemic injuries; 3.1% died during their hospitalization or on arrival.

Keywords: Epidemiology; ICU; United States

Introduction

Falls are a common cause of morbidity and mortality in individuals aged 65 years and older, with one-third of all community dwelling older adults sustaining at least one fall a year [1,2]. Approximately, 5% of all ocular injuries in the United States (US) are related to falls [3]. Previous studies have reported that fall-related open globe injuries (OGIs) are seen most commonly in women and older patients, and usually occur at home [4-6]. Common injuries associated with OGIs include facial/orbital fractures, eyelid laceration, traumatic cataract, vitreous hemorrhage, and retinal detachment [7]. Mir and coworkers [7] have noted a 6.6% increase in fall-related open globe injuries in recent years. Studies analyzing fall-related OGIs in older individuals are scarce in the literature. This study aims to characterize epidemiologic trends of fall related OGIs in those 65-89 years old stratified by gender.

Methods

This is a retrospective cross-sectional study of patients with OGIs associated with accidental falls using the National Trauma Data Bank (NTDB) from 2007 to 2014. The NTDB is a dataset provided by the American College of Surgeons [8]. Over 900 trauma centers in the US provide de-identified data to the NTDB, and the inclusion criteria include all patients with ICD-9-CM (International Classification of Diseases, Ninth Revision, Clinical Modification) discharge diagnosis ranging from 800.00 -959.9 with certain exclusions. All patients included either had been admitted for traumatic injury or died after receiving any evaluation or treatment [8].

To select our cohort, ICD-9CM codes were used to identify all older patients, ages 65-89 years, with OGIs associated with accidental falls (ICD-9CM: 871.0-871.2, 871.4-871.7, and 871.9). These patients were then subdivided into groups by gender and age (65-76 years and 77-89 years) for further analysis. Demographic data and associated injury data were collected for all patients. Statistical analysis was performed using IBM SPSS 23 software. Descriptive statistics were used to assess demographic variables, mortality, and associated injuries in older patients with OGIs associated with accidental falls. Pearson's chi-squared testing was used to compare

these variables by gender. P- values of <0.05 were considered statistically significant. Cases with unknown values were excluded.

Results

A total of 2,916 older patients 65 to 89 years of age with OGIs secondary to accidental falls were identified. A majority of patients were in the 77–89-year cohort (older group; n = 1908, 65.4%) vs the 65–76-year-old cohort (younger group; n = 1008, 34.6%). Most of the patients were females (n = 1753, 60.3%) with a 1.06:1.00 female to male ratio in the younger group compared to 1.86:1.00 in the older group. Most patients were White (n = 2315, 79.4%), followed by Black (n = 263, 9.0%), Hispanic (n = 149, 5.1%), and Asian (n = 56, 1.9%). Injuries most commonly occurred at home (n = 1879, 64.4%) followed by residential institutions (n = 322, 11.0%), and public buildings (n = 195, 6.7%). 730 patients (25.0%) required an intensive care unit (ICU) stay, 212 (7.3%) were on ventilators, and 90 patients (3.1%) died during their hospitalization or on arrival; 119 patients (5.1%) had blood alcohol levels above the legal limit, and 53 (2.3%) reported use of illicit drugs. 132 patients (4.5%) had an underlying diagnosis of dementia, and 102 (3.5%) were thought to be functionally dependent (Table 1 and 2).

Criteria		N (%)
Total		2916 (100.0)
Age	65-76 years	1008 (34.6)
	77-89 years	1908 (65.4)
Gender[a]	Male	1153 (39.7)
	Female	1753 (60.3)
Race	Asian	56 (1.9)
	Black	263 (9.0)
	Native American	5 (0.2)
	NH/PI	5 (0.2)
	Other/Not Reported	272 (9.3)
	White	2315 (79.4)
Ethnicity	Hispanic	149 (5.1)
Location	Farm	8 (0.3)
	Home	1879 (64.4)
	Industry	10 (0.3)
	Other	106 (3.6)
	Public Building	195 (6.7)
	Recreational Facility	28 (1.0)
	Residential Institution	322 (11.0)
	Street	149 (5.1)
	Unreported	219 (7.5)
Died		90 (3.1)
ICU admission		730 (25.0)
Ventilator use		212 (7.3)
BAC above the legal limit[a]		119 (5.1)
Illicit drug use[a]		53 (2.3)
Functionally dependent		102 (3.5)
Concurrent Injuries	Optic pathway/cranial nerve injury	16 (0.5)
	Orbital floor fracture	471 (16.2)
	Open wound of the ocular adnexa	293 (10.0)
	Ocular adnexal contusion	599 (20.5)
	Superficial eye injury	157 (5.4)
	Non-orbital floor skull facial fracture	779 (26.7)
	Spine trunk fracture	268 (9.2)
	Upper limb fracture	242 (8.3)
	Lower limb fracture	77 (2.6)
	Concussion	203 (7.0)
	Cerebral contusion/laceration	81 (2.8)
	Intracranial hemorrhage	510 (17.5)
	Dementia	132 (4.5)

Table 1: Patient and Injury Demographics.

[a]Values based on total available cases; unknowns excluded. NH/PI = Native Hawaiian/Pacific islander. BAC = Blood alcohol content.

Criteria		Male N (%)	Female N (%)	P value
Total		1153 (100.0)	1753 (100.0)	
Age	65-76 years	488 (42.3)	516 (29.4)	<0.001
	77-89 years	665 (57.7)	1237 (70.6)	
Race	Asian	23 (2.0)	33 (1.9)	0.829
	Black	108 (9.4)	155 (8.8)	0.629
	Native American	3 (0.3)	2 (0.1)	0.391
	NH/PI	2 (0.2)	3 (0.2)	1.00
	Other/Not Reported	114 (9.9)	151 (8.6)	0.263
	White	903 (78.3)	1409 (80.4)	0.178
Ethnicity	Hispanic	58 (5.0)	91 (5.2)	0.848
Location	Farm	6 (0.5)	2 (0.1)	0.065
	Home	739 (64.1)	1136 (64.8)	0.696
	Industry	6 (0.5)	4 (0.2)	0.209
	Other	49 (4.2)	57 (3.3)	0.160
	Public Building	71 (6.2)	124 (7.1)	0.334
	Recreational Facility	21 (1.8)	6 (0.3)	< 0.001
	Residential Institution	95 (8.2)	227 (12.9)	< 0.001
	Street	75 (6.5)	73 (4.2)	< 0.001
	Unreported	91 (7.9)	124 (7.1)	0.409
Died		42 (3.6)	47 (2.7)	0.141
ICU admission		310 (26.9)	419 (23.9)	0.069
Ventilator use		102 (8.8)	108 (6.2)	0.006
BAC above the legal limit[a]		84 (8.7)	35 (2.6)	<0.001
Illicit drug use[a]		29 (3.2)	24 (1.8)	0.029
Functionally dependent		32 (2.8)	70 (4.0)	0.081
Concurrent Injuries	Optic pathway/cranial nerve injury	8 (0.7)	8 (0.5)	0.397
	Orbital floor fracture	175 (15.2)	294 (16.8)	0.253
	Open wound of the ocular adnexa	137 (11.9)	155 (8.8)	0.008
	Ocular adnexal contusion	216 (18.7)	381 (21.7)	0.050
	Superficial eye injury	71 (6.2)	86 (4.9)	0.144
	Non-orbital floor skull facial fracture	311 (27.0)	465 (26.5)	0.790
	Spine trunk fracture	122 (10.6)	146 (8.3)	0.040
	Upper limb fracture	71 (6.2)	170 (9.7)	0.001
	Lower limb fracture	25 (2.2)	52 (3.0)	0.190
	Concussion	88 (7.6)	114 (6.5)	0.242
	Cerebral contusion/laceration	34 (2.9)	46 (2.6)	0.601
	Intracranial hemorrhage	201 (17.4)	304 (17.3)	0.949
	Dementia	45 (3.9)	87 (5.0)	0.179

Table 2: Patient and Injury Demographics by Gender.

[a]Values based on total available cases; unknowns excluded. NH/PI = Native Hawaiian/Pacific islander. BAC = Blood alcohol content.

Patients also sustained other ocular injuries, such as orbital floor fractures (471, 16.2%), open wounds of the ocular adnexa (293, 10.0%), adnexal contusions (599, 20.5%), superficial eye injuries (157, 5.4%), and optic pathway/cranial nerve injury (16, 0.5%). Other common systemic injuries included non-orbital facial fractures (779, 26.7%), intracranial hemorrhage (510, 17.5%), spine trunk fractures (268, 9.2%), and upper limb fractures (242, 8.3%); (Table 1).

When the cohort was stratified by gender, a greater proportion of women (70.6%) had OGIs in the older cohort (77-89 years) as compared to men (57.7%). Of the OGIs that occurred in residential institutions, 70.5% of cases occurred in women ($p < 0.001$). Of the OGIs that occurred in recreational facilities, 77.8% occurred in men ($p < 0.001$). A higher proportion of men (compared to women) were placed on ventilators (8.8% vs 6.2%, respectively; $p = 0.006$). Blood alcohol levels above the legal limit (8.7% vs 2.6%; $p < 0.001$) and illicit drug use (3.2% vs 1.8%; $p = 0.029$) were reported more often in men than women. More men had concurrent spine trunk fractures (10.6% vs 8.3%; $p = 0.040$) while more women had concurrent upper limb fractures (9.7% vs 6.2%; $p = 0.001$) (Table 2).

Discussion

This study aims to characterize epidemiologic trends in hospitalized fall-related OGIs in older persons (65 to 89 years). Morikawa., *et al*. [4] and Emami-Naeini., *et al*. [5] have conducted retrospective reviews of fall-related OGI's, but these studies included patients of all ages and were institution specific. OGIs occur in 1.6 to 4.5 per 100,000 individuals and involve a variety of mechanisms including falls, assault, and motor vehicle collisions among others [7,9]. While the overall incidence of OGIs is decreasing in the United States, the incidence of fall-related OGIs is increasing [7,10].

Older individuals are predisposed to falls due to gait and balance disorders, cognitive impairment, visual disorders, and alcohol use, among other factors [1,11]. In our study, 65.4% of individuals were in the older cohort (77-89 years) as compared to the younger (65-76 years), which is not surprising since the likelihood of falls rises with increasing age [11,12]. 60.3% of individuals were women, which is higher than the 2019 US census data which showed that 54.7% of individuals over 65 were women [13]. Older women are more prone to falls due to greater impaired balance compared to older men, and a higher rate of osteoporosis [14-17].

In this study, most patients were White (79.4%), which is in concordance with the 2019 national census data in which White individuals comprised 76.3% of the US population [18]. The most common location for OGIs was at home followed by a residential institution. This finding is consistent with the literature in which home was the most common site for OGIs overall, specifically in females [19,20]. The mortality rate reported in this study (3.1%) is in accord with the mortality rate of 5.93% reported by Wen-Shen Lee., *et al*. [21] in a study of 275 inpatients with ocular trauma associated with falls. In the current study, 25% of the patients required ICU admission, which is higher than that reported in the literature in patients with (8.5%) and without (6.0%) ophthalmic trauma [21-23]. The present study just included inpatients, which may bias the results towards more serious injuries. Common facial injuries associated with fall-related OGIs in the current study included non-orbital floor skull facial fracture (26.7%), ocular adnexal contusion (20.5%), and orbital floor fracture (16.2%), which is consistent with the literature [7,24,25].

A majority (70.6%) of women in this study were in the 77–89-year-old cohort. The 2019 US census data, however, shows that of all women above the age of 65, only 42.5% were in the 75-85+ cohort [13]. This suggests that women over 75 years of age are at a higher risk for fall related OGIs. The predominance of women in the older cohort may be related to frailty, more commonly seen in older women [26]. Henry., *et al*. [27] reported that the most common frailty-defining diagnoses include malnutrition, decubitus ulcer, difficulty walking, vision impairment, and fall. In addition, compared to older men, older women have an increased fear of falling with subsequent activity restriction, which can paradoxically raise the risk of falling [28].

Interestingly, in a study conducted by Ojuok., *et al*. [29] on adults over the age of 20 admitted to US hospitals due to OGI secondary to any cause, men comprised 71% of all cases. As such, while all cause OGIs are more common in men, these data indicate that OGIs secondary to falls are more common in older women compared to men.

This study being a retrospective database review, is inherently limited by the lack of homogeneity, missing data, and selection bias during data reporting. Data from the NTDB may underestimate the incidence of ophthalmic injuries as it contains a disproportionate number of cases from larger hospitals with severely injured pa-

tients. Given the large sample size and detailed inclusion criteria, we believe that these limitations are mitigated and that the findings of our study may be generalizable.

Severe ocular trauma, OGIs, associated with falls in the older adults (65-89 years old) have an overall mortality rate of 3.1%. Most of these injuries occur at home and in women. A quarter of patients needed ICU admission and 7.3% required ventilator use. These grim statistics regarding fall-related morbidity is another reason to focus on preventative measures against falls in older adults.

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