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Unintentional injuries treated in hospital emergency departments among persons aged 65 years and older, United States, 2006–2011^{☆,☆☆}

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Abstract

Introduction: With the aging of the United States population, unintentional injuries among older adults, and especially falls-related injuries, are an increasing public health concern.

Methods: We analyzed emergency department (ED) data from the Nation wide Emergency Department Sample, 2006–2011. We examined unintentional injury trends by 5-year age groups, sex, mechanism, body region, discharge disposition, and primary payer. For 2011, we estimated the medical costs of unintentional injury and the distribution of primary payers, plus rates by injury mechanisms and body regions injured by 5-year age groups.

Results: From 2006 to 2011, the age-adjusted annual rate of unintentional injury-related ED visits among persons aged 65 years increased significantly from 7987 to 8163, per 100,000 population. In 2011, 65% of injuries were due to falls. Rates for fall-related injury ED visits increased with age and the highest rate was among those aged 100. Each year, about 85% of unintentional injury-related ED visits in this population were expected to be paid by Medicare. In 2011, the estimated lifetime medical cost of unintentional injury-related ED visits among those aged 65 years was \$40 billion.

Conclusion: Increasing rates of ED-treated unintentional injuries, driven mainly by falls among older adults, will challenge our health care system and increase the economic burden on our society. Prevention efforts to reduce falls and resulting injuries among adults aged 65 years have the potential to increase wellbeing and reduce health care spending, especially the costs covered by Medicare.

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^{☆☆}The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention

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Conflicts of interest to report
None.

Practical applications: With the aging of the U.S. population, unintentional injuries, and especially fall-related injuries, will present a growing challenge to our health care system as well as an increasing economic burden. To counteract this trend, we must implement effective public health strategies, such as increasing knowledge about fall risk factors and broadly disseminating evidence-based injury and fall prevention programs in both clinical and community settings.

Keywords

Unintentional injury; Older adults; Elderly; Emergency department; Falls

1. Introduction

In the United States, the number of older adults (those aged 65 years and older) is expected to increase from 54 million, or 17% of the population in 2015, to 83 million, or 23% of the population, in 2030 (U.S. Census, 2014). Injury is the eighth leading cause of death among older adults (Centers for Disease Control and Prevention [CDC], 2013a). In 2011, older adults accounted for over 20.3 million hospital emergency department (ED) visits and 25% of these visits were for unintentional injuries (NCHS, 2011). Clearly, unintentional injuries among older adults are an important public health concern.

Among older adults, falling is the leading mechanism of both fatal and nonfatal unintentional injuries (Centers for Disease Control and Prevention [CDC], 2014). In 2011, unintentional falls accounted for 22,901 injury deaths and 2.4 million nonfatal injuries treated in EDs (Centers for Disease Control and Prevention [CDC], 2013c). Unintentional fall injury rates increase sharply with age and these injuries are associated with significant morbidity, limited mobility, decreased physical functioning, and loss of independence (Lo, Brown, Sawyer, Kennedy, & Allman, 2014; Sterling, O'Connor, & Bonadies, 2001; Stevens, 2005).

This study provides nationally representative data on trends in unintentional injury rates for ED visits among persons aged 65 years, with an emphasis on fall-related injuries.

2. Methods

Data on hospital ED visits for unintentional injuries were from the U.S. Agency for Healthcare Research and Quality, Healthcare Cost and Utilization Project (HCUP)–National Emergency Department Sample (NEDS). HCUP–NEDS, is the largest all-payer ED database publicly available in the United States. Injury diagnoses and external causes of injury are coded using ICD-9-CM (International Classification of Diseases, Ninth revision, Clinical Modification) codes.

Although NEDS provides ICD-9-CM codes for up to 15 diagnoses per ED visit, injuries were identified using the first-listed, or principal, diagnosis codes to avoid multiple counting of discharge records.(HCUP, 2006) The ICD-9-CM codes used to identify injuries were: 800–908, 909.0–909.2, 909.4, 909.9, 995.5, 910–994, and 995.80–995.85. The ICD-9-CM external cause codes (E-codes) used to define unintentional injuries were E800–E869 and E880–E929. Specific mechanisms of injury were defined using the first-listed E-code in

the ED record and applying the Centers for Disease Control and Prevention's (CDC) recommended framework of E-code groupings (Centers for Disease Control and Prevention [CDC], 2011b). Diagnosis code groupings for the primary body region injured were defined using the Barell matrix (Centers for Disease Control and Prevention [CDC], 2011a).

Analysis variables included age, sex, mechanism of injury, and primary body part injured. Also included were patients' discharge disposition from the ED and the expected primary payer.

Data were weighted to provide national estimates of annual numbers and rates per 100,000 population. From 2006 through 2011, age-adjusted rates were calculated based on the U.S. Census Bureau's bridged-race postcensal population estimates of the resident population (Centers for Disease Control and Prevention [CDC], 2013b). Rates were age-adjusted by 5-year age groups to the standard 2000 U.S. population. Joinpoint regression software from the National Cancer Institute (NCI, 2014) was used to calculate the average annual percent changes (AAPCs) in unintentional injury incidence rates from 2006 to 2011. AAPCs were considered significantly different from zero for p -values < 0.05 . All statistical analyses were performed using SAS Systems for Windows, version 9.3 (SAS Institute, Cary, NC).

Lifetime medical costs (in 2013 dollars) for unintentional injury-related ED visits were estimated based on weighted 2011 HCUP-NEDS data for older adults treated in hospital EDs using the Web-based Injury Statistics Query and Reporting System (WISQARS; Centers for Disease Control and Prevention [CDC], 2013a). Methods for using WISQARS to estimate medical costs, including facility and non-facility costs, have been described elsewhere (Lawrence & Miller, 2014).

3. Results

3.1. Trends in unintentional injury-related ED visits –2006 to 2011

Table 1 shows the trends in rates of unintentional injury-related ED visits from 2006 to 2011 by age, sex, injury mechanism, body region injured, and disposition. The annual rates among adults aged 65 years and older increased significantly from 7987 to 8164 per 100,000 population. The average annual percent change (AAPC) was 0.5 ($p < 0.004$).

Annual rates increased significantly for each age group from 70–74 to 90–94 ($p < 0.05$). The greatest rate increase occurred among people aged 85–89 years (AAPC = 1.2) followed by those aged 80–84 years (AAPC = 1.0). Rates of unintentional injury-related ED visits for both males and females increased significantly over the study period (AAPC = 0.5 for males, AAPC = 0.6 for females, $p < 0.05$).

Falls were the most frequent unintentional injury mechanism followed by motor vehicle (MV) injuries. Rates of fall-related ED visits increased significantly (AAPC = 1.1, $p < 0.05$) while motor vehicle injury rates decreased significantly (AAPC = -2.6 , $p < 0.05$).

The highest rates were for injuries of the extremities followed by other head and neck injuries. Over the study period, the rates for TBI and other head and neck injuries increased

significantly (AAPC = 5.9 and 3.4 respectively, $p < 0.05$). In contrast, the rates for extremity injuries decreased significantly (AAPC = -1.0 , $p < 0.05$), with the largest decrease associated with hip fractures (AAPC = -2.2 , $p < 0.05$).

Each year disposition rates were highest for patients discharged to home followed by hospital admission.

In 2011, the estimated total lifetime medical cost of unintentional injury-related ED visits among people 65 years and older was \$40.8 billion (\$12,129/visit). This included \$33.3 billion (\$40,620/visit) for those admitted or transferred and \$7.5 billion (\$2942/visit) for those discharged to home.

3.2. Fall related injury ED visits in 2011—from 65 to 100+ years age

Rates for falls were much higher than for other mechanisms and also increased sharply with age, reaching a peak among people aged 95–99 years (Fig. 1). The fall rate among people aged 95–100+ was more than seven times higher than that of people aged 65–69 years. Rates for other unintentional injury mechanisms showed no significant change with age.

About 80% of fall-related injuries included TBI, non-TBI head and neck injury, extremity fractures, hip fractures and other extremity injury (Fig. 2). The highest rates were for non-TBI head and neck injuries. All types of fall-related injury ED visits increased with age with the sharpest rate increases for hip fractures and head and neck injuries. People aged 90+ had hip fracture rates 24 times higher, head and neck injury rates 12 times higher, and TBI rates 8 times higher than people aged 65–69.

The proportion of unintentional injury-related ED visits in which Medicare was the expected payer varied by age. The percentage increased from 71.5% among those aged 65–69 years to 93.3% among those 90 years and older (Fig. 3). Conversely, the percentage for private payers decreased significantly, from 20.2% among those aged 65–69 years to 4.5% for those 90 years and older ($p < 0.001$).

4. Discussion

Every year, about three million older adults are treated in EDs for unintentional injuries. From 2006 to 2011, the rate of unintentional injury-related ED visits increased significantly. Much of this increase was due to an increase in the rate of fall-related injuries.

In 2011, falls comprised 65% of ED visits for unintentional injuries among older adults. Rates of ED visits due to falls, as well as serious fall-related injuries, increased rapidly with age, reaching a peak around age 95, with the exception of TBI and head and neck injuries, which continued to increase.

Other studies have observed an increase in fall injury rates. In Canada, fall-related injury rates among older adults increased about 6% a year from 2002 to 2009 (Hill, Pinto, Nathens, & Fowler, 2014). From 2006 to 2010, about 85% of injuries that required hospital admission each year in Canada were due to falls (PHAC, 2014).

The increase in fall rates may be a result of people living longer. People born in 1929–1931 had an average life expectancy of 59.2 years while people born in 1941–1951 had an average life expectancy of 68.1 years (Shrestha, 2005). Declines in muscle strength with age contribute to increased likelihood of falls among older adults (Papa, Foreman, & Dibble, 2015). Many older adults also are living longer with chronic medical conditions, such as arthritis and diabetes, and taking multiple medications, all factors that can increase fall risk (Helgadottir, Laflamme, Monarrez-Espino, & Moller, 2014; Sturnieks et al., 2004; Tilling, Darawil, & Britton, 2006; Tinetti et al., 2014).

The U.S. Census estimates that there are now about six million persons aged 85 years and older and this number may reach 19 million in 2050 (U.S. Census, 2014). Such an increase in the oldest portion of our population, along with the documented increase in the rate of unintentional injuries, will mean a substantial increase in injuries, especially fall-related injuries, which will place a significant burden on our health care system.

In 2011, the estimated total lifetime medical cost for unintentional injury-related ED visits among older adults was \$40 billion. The percentage for which Medicare was the expected payer increased with age, from 70% among people aged 65–69 years to 92% among people aged 90 and older. The need for Medicare to provide coverage will become increasingly important as our population ages.

Because falls are the major cause of unintentional injuries among older adults, the costs of fall injuries will continue to increase and to challenge our health care system. Other developed countries with aging populations are facing similar challenges. Annual costs associated with falls were over 470 million pounds in Scotland (population five million; Craig et al., 2013) and 675.4 million euros in The Netherlands (population 16 million; Hartholt et al., 2012). The economic burden of falls should be a driver for implementing falls interventions.

This study has several limitations. First, because NEDS reports one discharge record per ED visit and includes revisits for the same injury incident, these data represent patient visits rather than individual patients. Second, results were based only on the principal diagnosis and the first-listed external cause code. While we may have missed a number of relevant diagnoses, this approach allowed us to avoid double or multiple counting discharge records when the ED visits had two more injury ICD-9 codes.

5. Conclusion

With the aging of the U.S. population, unintentional injuries, and especially fall-related injuries, present a growing challenge to our health care system as well as an increasing economic burden. To counteract this trend, we must implement effective public health strategies, such as increasing knowledge about fall risk factors and broadly disseminating evidence-based injury and fall prevention programs in both clinical and community settings (Stevens, 2005).

Biographies

Xinyao de Grauw received her MD and PhD in neuroscience in China and is a MPH 2016 candidate at Rollins School of Public Health, Emory University. She was a guest researcher and an intern at Injury Center at the Centers for Disease Control and Prevention in 2014 and 2015, respectively. Her research interests include injury prevention, especially traumatic brain injury, epilepsy and older adult falls. Dr. de Grauw has published over twenty peer-reviewed journal articles and has contributed a chapter on the diagnosis of brain diseases using CT and MRI technology.

Joseph Lee Annest, PhD, MS, retired as the Director of the Office of Statistics and Programming, in the National Center for Injury Prevention and Control, CDC after more than 33 years of federal public service. Among his other accomplishments, Dr. Annest provided federal leadership in establishing the National Electronic Injury Surveillance System—All Injury Program (NEISS-AIP) that provides national estimates of nonfatal injuries treated in U.S. hospital emergency departments and in developing and maintaining the Web-based Injury Statistics Query and Reporting System (WISQARS™) that provides national and state data on fatal and nonfatal injuries in the United States.

Judy A Stevens received her PhD from Emory University and joined the Injury Center at the Centers for Disease Control and Prevention in 1996 as an epidemiologist in the Division of Unintentional Injury Prevention. Now semi-retired, Dr. Stevens continues to focus on older adult falls and fall prevention. As a national expert, she has conducted epidemiologic research on fatal and nonfatal falls. In addition to her research, Dr. Stevens has provided technical assistance and oversight to CDC-funded studies, conducted by universities and state health departments, that develop, implement, and evaluate older adult fall prevention programs. Dr. Stevens has published over eighty peer-reviewed journal articles and has contributed chapters on older adult falls to six textbooks. She also has developed resources for healthcare providers as well as educational materials for older adults and their caregivers.

Likang Xu, MD, MS, is a Mathematical Research Statistician in the National Center for Injury Prevention and Control, CDC. He received his MD degree from Tongji Medical University in Wuhan, China and his MS degree in biostatistics from University of Alabama at Birmingham. His expertise is in study design, data management, and statistical analyses.

Victor Coronado MD, MPH, is a medical officer at the Centers for Disease Control and Prevention. He received his MD from the Federico Villarreal University, Lima, Peru. Dr. Coronado received a Master in Public Health from Tulane University School of Public Health and Tropical Medicine. Dr. Coronado is an experienced neuro-epidemiologist and researcher. His current research interests include injury, emerging tropical diseases, and travel related medicine.

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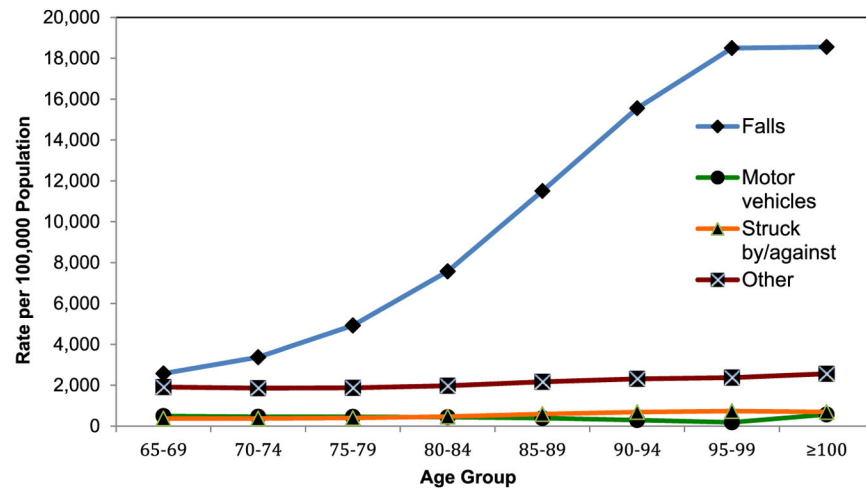


Fig. 1.

Rates for unintentional injury-related emergency department visits for persons aged 65 and older by age group and mechanism of injury, United States, 2011. (Data are from the US Agency for Healthcare Research and Quality, Healthcare Cost and Utilization Project—National Emergency Department Sample.)

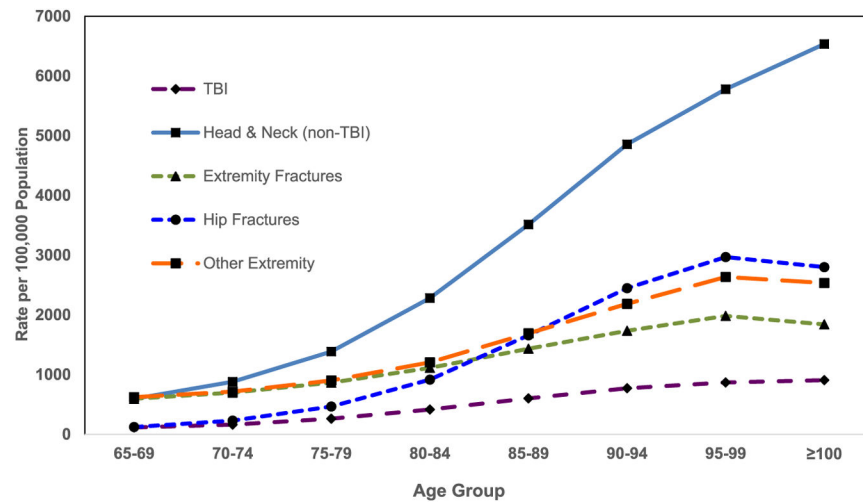


Fig. 2. Rates of unintentional fall-related injury emergency department visits for persons aged 65 and older by age group and body region injured, United States, 2011. (474,830 (21.5%) weighted records with other than listed body region and/or nature of injury are not displayed. Data are from the US Agency for Healthcare Research and Quality, Healthcare Cost and Utilization Project—National Emergency Department Sample.)

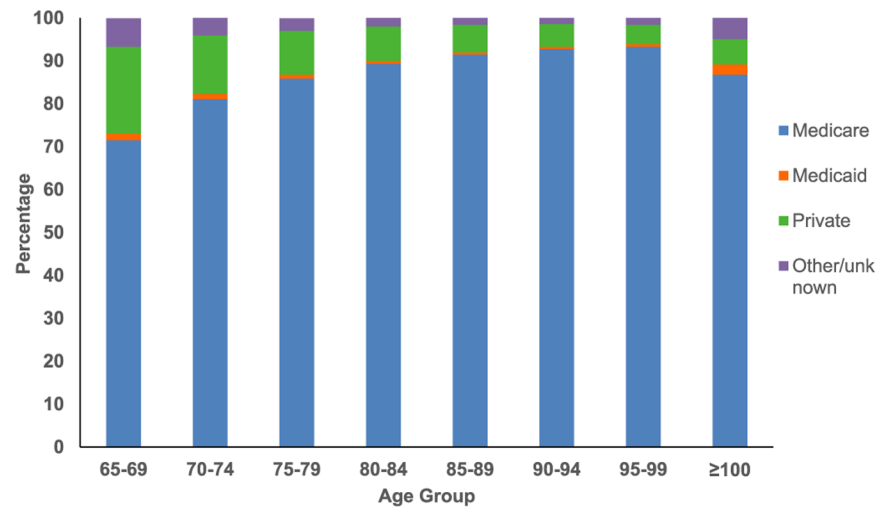


Fig. 3. Proportion of unintentional injury-related emergency department visits for persons aged 65 and older by age group and expected primary payer, United States, 2011. (Data are from the US Agency for Healthcare Research and Quality, Healthcare Cost and Utilization Project—National Emergency Department Sample.)

Table 1

Age adjusted annual rates per 100,000 population of unintentional injury-related emergency department visits for persons aged 65 and older, United States, 2006–2011[§].

	Rate						AAPC*	P-value of AAPC
	2006	2007	2008	2009	2010	2011		
Total	7987	7917	8086	8097	8145	8164	0.5	0.004
<i>Age group</i>								
65–69	5390	5409	5391	5402	5343	5351	–0.2	0.075
70–74	5985	5948	6000	6024	6033	6064	0.3	0.013
75–79	7430	7392	7473	7512	7669	7652	0.7	0.009
80–84	10,058	9932	10,162	10,147	10,419	10,455	1.0	0.012
85–89	13,862	13,857	14,351	14,426	14,570	14,661	1.2	0.003
90–94	18,118	18,162	18,789	18,865	18,857	18,848	0.9	0.029
95–99	20,660	21,374	21,608	21,259	22,238	21,794	1.0	0.057
100+	21,785	22,509	23,056	21,754	21,937	22,375	0.1	0.928
<i>Sex</i>								
Male	6530	6519	6624	6610	6658	6699	0.5	0.004
Female	9056	9044	9175	9202	9274	9284	0.6	0.003
<i>Injury mechanism</i>								
Falls	5057	5105	5260	5321	5319	5341	1.1	0.048
Motor vehicles	520	503	490	469	475	452	–2.6	0.001
Struck by/against	429	413	415	420	431	427	0.3	0.491
Cut/pierce	408	387	375	367	364	367	–2.2	<0.000
Overexertion	355	339	333	315	309	230	–3.3	<0.000
Poisoning	97	98	106	107	111	112	3.1	0.003
Hot object/substance	39	40	37	36	38	36	–1.4	0.111
Fire/flame	16	14	16	18	17	15	1.0	0.677
Other	1064	1069	1051	1042	1080	1112	0.8	0.200
<i>Body region injured</i>								
Extremities	4312	4266	4242	4143	4115	4119	–1.0	0.003
Upper extremity	2032	2007	1982	1933	1938	1948	–0.9	0.019
Lower extremity	1358	1359	1352	1338	1339	1342	–0.3	0.029
Hip	922	8,99	908	872	838	829	–2.2	0.002
Head & neck (non-TBI)	1589	1609	1677	1788	1827	1844	3.4	0.001
Torso	872	866	875	865	864	867	–0.1	0.334
Spine & upper back	536	534	556	541	554	552	0.6	0.117
TBI	246	263	295	318	329	323	5.9	<0.0001
Unclassified	433	434	440	442	456	459	1.3	0.002
<i>Disposition of patient</i>								
Home	5782	5873	6016	6050	6116	6142	1.3	<0.0001
Admitted	1523	1530	1556	1524	1493	1439	–1.0	0.026
Transferred	402	418	464	484	499	542	6.1	0.0002

	Rate						AAPC*	P-value of AAPC
	2006	2007	2008	2009	2010	2011		
Left against medical advice	23	24	24	24	23	25	1.1	0.251
Died	5	4	5	5	4	7	2.8	0.470
Destination unknown	252	123	21 [^]	9 [^]	10	10	-49.3	0.006

TBI: traumatic brain injury.

^sData are from the US Agency for Healthcare Research and Quality, Healthcare Cost and Utilization Project—National Emergency Department Sample.

* Average Annual percent change (AAPC) calculated by using Joinpoint regression analysis.

[^] If the relative standard error was over 30% or equal to 0, the value of the estimate was considered unreliable and was not reported.