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Mortality after distal radial fractures in the Medicare population

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Abstract

The occurrence of a low energy fracture of the distal radius increases the risk for another, more serious fracture such as a proximal femoral fracture. Early mortality after proximal femoral fracture has been widely studied, but the association between distal radial fracture and mortality is unknown. The date of death for all Medicare beneficiaries who sustained an isolated distal radial fracture in 2007 was determined using Medicare Vital Statistics files. The adjusted mortality rate for each age-sex group was calculated and compared with published US mortality tables. Distal radial fractures were not associated with an increased mortality rate. In fact, beneficiaries had a significantly *lower* mortality rate after distal radial fractures than the general population. This may be related to the injured beneficiaries' involvement in the healthcare system. Mortality rate did not vary significantly based on time from injury. Our results indicate that any mortality is unlikely to be attributable to the distal radial fracture or its treatment.

Level of Evidence: III

Keywords

fracture prevention; fragility fractures; Medicare; osteoporosis

INTRODUCTION

Falls are a public health concern. More than 30% of people aged 65 years or more fall each year (Centers for Disease Control and Prevention, 2015, Practice, 2013). Falls are the leading cause of injury for emergency department visits worldwide (Polinder et al., 2005). Fractures are a common consequence of falls, including distal radial fractures (DRFs). Fall-related DRFs occur in the US at a rate of 237/100,000 women aged 65 years or more and 58/100,000 for men and represent nearly 70% of all DRFs to this age group (Chung et al.,

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Conflict of Interest

None declared

2011, Orces, 2013). Osteoporosis is a widely recognized risk factor for DRFs, increasing the risk of fracture nearly nine times for women over 60 (Harness et al., 2012). Patients who sustain DRFs are nearly five times more likely to have another DRF (Robinson et al., 2002). Furthermore, these patients have a five-fold increased risk of experiencing a vertebral fracture (Cuddihy et al., 1999). The relationship between DRF and subsequent increased risk of proximal femoral fracture is perhaps most well-documented (Cooper et al., 1993, Lauritzen et al., 1993, Owen et al., 1982, Schousboe et al., 2005). It is also well known that a proximal femoral fracture is often associated with an increased risk of mortality, both shortly after injury and more than 5 years from the date of fracture (Bass et al., 2007, Endo et al., 2005, Johnell et al., 2004, Lu-Yao et al., 1994, Richmond et al., 2003).

Death is not a common complication of DRF; more often participants are simply considered lost to follow-up without further investigation.(Bentohami et al., 2014) But given the relationship between DRF and proximal femoral fracture and between proximal femoral fracture and early mortality, there may be a relationship between DRF and early mortality. Several studies have included DRFs, forearm fractures, or wrist fractures in their examinations of mortality after osteoporotic fractures. Whereas proximal femoral and vertebral fractures are undoubtedly associated with increased mortality, results after DRF have varied. A sample of elderly DRF patients from Pennsylvania died at a rate 14% higher than the general population (Rozenal et al., 2002). In a Swedish sample, low-energy DRFs were associated with increased risk of death up to 5 years after injury for women aged 60 or more years (Johnell et al., 2004). Other studies have found no significant differences in mortality between samples of DRF patients and the general population (Barrett et al., 2003, Cooper et al., 1993, Ioannidis et al., 2009, Morin et al., 2011, Shortt and Robinson, 2005).

Many previous studies have been hampered by small sample sizes and short follow-up periods, which has produced conflicting results that make it difficult to understand the relationship between DRF and early mortality. Knowing whether increased mortality is attributable to DRF informs the appropriate distribution of limited healthcare resources and allows for the creation and implementation of interventions aimed at the reduction of mortality. The aim of this project was to carry out a retrospective national, population cohort study to calculate mortality rate and determine predictors of early mortality after DRF in Medicare beneficiaries.

METHODS

Data source

We obtained a 100% dataset from 2007 from the United States Centers of Medicare and Medicaid Services (CMS). Medicare is a social insurance program administered by the US federal government. All legal residents aged 65 years or more are eligible, as are those who are permanently disabled or have been diagnosed with end-stage renal disease or amyotrophic lateral sclerosis. In 2012, the most recent year for which data are available, 53 million Americans, 42 million aged 65 years or more and 9 million who were disabled, were enrolled in at least one Medicare program (Services, 2014). Census estimates for 2012 indicate a population of 43 million for those aged 65 or more (U.S. Census Bureau, 2014).

Because of the nearly complete coverage (98%), Medicare beneficiaries are often used to represent all Americans aged 65 or more.

We received all claims from the Medicare Provider Analysis and Reviews (MedPAR) file (Medicare Part A), and the Outpatient and Carrier file (Medicare Part B) that listed an International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnosis code for fractures of the radius and/or ulna. Our cohort extraction methods have been previously described (Chung et al., 2011). Briefly, to ensure completeness of data, beneficiaries were excluded if they were not enrolled in Medicare for all 12 months of 2007. Beneficiaries may opt to pay additional premiums to have their care provided by a CMS-approved health maintenance organization (HMO). Less than 5% of beneficiaries receive coverage via HMOs. HMOs are not required to provide data back to CMS for inclusion in research databases. Because data for beneficiaries covered by HMOs may not be complete, we have excluded them. We also excluded beneficiaries whose claims included diagnoses of bone or metastatic cancer and beneficiaries under the age of 65 and over the age of 100. Claims were further filtered for those listing the ICD-9-CM codes most frequently used for DRF. To exclude fractures that occurred before January 1, 2007, claims were excluded if they did not contain one of the Current Procedural Terminology (CPT) codes indicating treatment of a DRF within 2 weeks of the first claim listing a DRF diagnosis. For this analysis we wished to examine only those beneficiaries with isolated DRFs that occurred without any additional serious injury. These fractures are most likely to be the result of a standing-height fall. Beneficiaries were excluded if the first DRF claim included ICD-9-CM codes for any other fractures, neurological injuries (traumatic brain injury, subdural haematoma, and epidural haematoma), solid organ injuries (liver laceration/contusion, spleen laceration/contusion, bowel injury, diaphragmatic rupture, and kidney laceration/contusion), pneumothorax, or haemothorax.

The primary outcome measure of our analysis was death. To determine the date of death, we obtained the CMS Vital Status Files for 2007-2013, a file updated daily to ensure that benefits are not paid for the care of dead beneficiaries (Cooper et al., 1993, Ioannidis et al., 2009, Johnell et al., 2004). The age, sex and race of patients were obtained from the Medicare Beneficiary Summary File. Published socioeconomic status (SES) scores were used to assign each beneficiary an SES based on their residential zip code. Each beneficiary was assigned a comorbidity score calculated using an adapted version of the Elixhauser Comorbidity Index applied to claims before the date of injury (Elixhauser et al., 1998). To examine whether DRF treatment influenced survival of beneficiaries, we defined a single treatment for each beneficiary as the most invasive treatment for DRF. For example, if a beneficiary underwent closed reduction and then external fixation 1 week later, the recorded treatment was external fixation. Published US mortality tables were used to compare mortality rate between the studied cohort and an age- and sex-matched US general population (Wonder).

Statistical analysis

We first described the characteristics of beneficiaries who had a date of death on December 31, 2013 or earlier and those who did not. Chi-square tests were done to detect any

association between each characteristics and death. We obtained the total population of each age cohort, number of deaths and crude mortality rate for the US general population, stratified by sex. Using the age composition of the US general population, we calculated age-adjusted total number of beneficiaries, number of deaths and age-adjusted mortality rates for each age frame for male and female members of the cohort. We then converted the difference between the adjusted mortality rate among the DRF cohort and the crude mortality rate of US general population for each age/sex group into a z -score and calculated the empirical p -value for the significance of this difference. Significance was set at $p<0.05$.

RESULTS

In 2007 81,568 Medicare beneficiaries were treated for an isolated DRF. Their demographic data are presented in Table 1. As of December 31, 2013, 40% of the original cohort was deceased. Beneficiaries who died were on average 6.6 years older at time of fracture than beneficiaries who survived (95% CI: 6.4 to 6.7, $p<0.001$). They had a mean comorbidity score of 17, compared to a mean score of 9 in those who were still alive ($p<0.001$). The mortality rate after DRF did not increase in comparison with age- and sex-matched members of the general population (Figure 1). Beneficiaries actually had a significantly *lower* mortality rate after DRF than the general population. The mortality rate did not vary significantly based on the time from injury (Table 2).

Female sex was associated with a significantly decreased risk of death (Hazard ratio (HR) 0.77) (Table 3). Beneficiaries who were Asian, American Indian, Alaskan Native, Hawaiian Native, or Pacific Islander had a decreased risk of death in comparison with white beneficiaries (HR 0.83). Beneficiaries who were treated operatively also had a decreased risk of death.

DISCUSSION

Our study demonstrates that there is no increased risk of mortality to Medicare beneficiaries after a DRF and, in fact, mortality is lower than that of the general US population. This is not an unexpected finding and may be due to regular visits with a healthcare provider after DRF that may allow other conditions, which may contribute to mortality, to be identified and treated (Morin et al., 2011, Shortt and Robinson, 2005). Additionally, the mortality rate of the cohort did not vary as the time from fracture increased. Mortality is thought to be attributable to a particular event if it is highest immediately after the event and then tapers off gradually (Johnell et al., 2004). This pattern of mortality is typically seen after proximal femoral fracture (Bass et al., 2007, Ioannidis et al., 2009, Melton et al., 2013, Morin et al., 2011). In the DRF cohort, the mortality rate was lowest in the year of fracture, perhaps attributable to the aforementioned involvement with healthcare, and then remained steady for 5 years after fracture. This suggests that any mortality after DRF is unlikely to be attributable to the fracture or its treatment.

Although there was no general increase in mortality within the cohort, there were groups that were more at risk. Beneficiaries who were older and those with more comorbidities were at a higher risk of death. Male beneficiaries were also at higher risk. This is likely to be

because male beneficiaries had a higher mean comorbidity score at baseline. Some factors were associated with lower risk of death. Beneficiaries whose race was categorized as “other” had a lower risk of death than white beneficiaries. This may be because the “other” category was comprised largely of Asian-American and Hispanic women. Women of Asian or Hispanic descent have the two highest life expectancies of any American gender/race subgroup (Office of Minority Health, 2014, Office of Minority Health, 2014). Finally, beneficiaries who were treated operatively were at lower risk of death. This is consistent with our previous findings that beneficiaries with more comorbidities are less likely to be treated by internal fixation (Chung et al., 2011). This is likely to be true for all surgical treatment methods and indicates that surgical treatments are used in healthier beneficiaries.

Our results are counter to previous publications. Rozental et al. (2002) found decreased survival up to 7 years after fracture in an American sample comprised of the authors’ own patients aged 65 years or more. Johnell et al. (2004) examined a Swedish sample aged 60 years or more selected from records at the authors’ institution and found increased risk of death up to 5 years after fracture, although this could not be attributed directly to the fracture. We set out to confirm these interesting findings. We included only isolated DRFs to target low-energy, osteoporotic fractures as much as possible and used Medicare data to increase the sample size and power. After these adjustments the deleterious effects of DRFs on mortality were not found.

A notable limitation of this study is the lack of information about cause and manner of death. Without this information we are unable to exclude beneficiaries whose deaths were not natural. However, the homicide rate for people aged 65 or more in 2010 (the most recent year available) was 2/100,000, the lowest rate for any age group; the suicide rate was 15/100,000 (Murphy et al., 2013). An estimated 14 deaths in the DRF cohort could be due to homicide or suicide, a negligible number. It would have been interesting to know the incidence of accidental death in our cohort. The US Centers for Disease Control and Prevention National Death Index (NDI) contains the cause and manner of death, along with all other data recorded on the death certificate. However searching the NDI is done manually and this was neither logistically nor financially feasible for a cohort of this size (2014). Another limitation brought about by the large cohort size is the use of the general US population aged 65 years and more as the control group. Ideally this study should be performed as a case-control study with the controls matched for age, sex, and comorbidities. Nevertheless, the increased statistical power and greater generalizability afforded by using a large dataset would tend to outweigh this particular limitation (Malay et al., 2012).

Falls and fragility fractures are worldwide problems. Populations in developed countries are living longer than ever before, providing many more years of fall risk (Organization, 2007). Low-energy DRFs resulting from falls are considered to herald the presence of osteoporosis and a risk of future fractures. However, as our analysis shows, early mortality is not likely to follow them. DRFs generally occur in younger, more agile, and more healthy adults. Nevertheless, even non-injurious falls can lead to fear of falling and reduction of physical activity, resulting in loss of strength, balance and agility (Shumway-Cook et al., 2009). These factors increase the risk of a future fall resulting in a serious fracture, such as a proximal femoral fracture. These fractures are a tremendous burden to patients, their

families and healthcare systems. Proximal femoral fractures frequently necessitate inpatient hospitalization, extensive rehabilitation and expensive residential care. The monetary costs pale in comparison to the psychological liability of loss of independence and the feeling of being a burden to one's family and friends. Despite this, DRF treatment is often limited to the fracture alone. Less than 20% of patients are referred for osteoporosis testing or treatment after a diagnosis of DRF and even fewer receive fall prevention counselling (Aghamirsalim et al., 2012, Cuddihy et al., 2002, Rozental et al., 2008, Tosi et al., 2008). There is generally an interval of approximately 10 years between DRF and proximal femoral fracture (Robinson et al., 2002, Schousboe et al., 2005). In the year after a DRF a patient is regularly seen by a healthcare provider, making this an opportunity to address prevention, including osteoporosis screening and treatment, gait training, exercise and alteration of risk-prone environments at both the individual and community level (Carande-Kulis et al., 2015, Grahn Kronhed et al., 2006, Guse et al., 2015, Sarfani et al., 2014, Tosi et al., 2008). As healthcare resources dwindle, prevention programmes will become more important. Further studies should examine the cost-effectiveness of interventions and their success in preventing fractures.

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Figure 1. Mortality rate for Medicare beneficiaries diagnosed with a distal radius fracture in 2007 and an age- and sex-matched general United States population. (a) Male. (b) Female.

Table 1

Demographic analysis of the Medicare distal radial fracture cohort.

	Surviving [*] N (%)	Deceased N (%)
	49,154 (60%)	32,414 (40%)
<i>Sex</i>		
Female	42,956 (87%)	27,316 (84%)
Male	6,198 (13%)	5,098 (16%)
<i>Race</i>		
White	45,313 (92%)	30,305 (93%)
African-American	1,376 (3%)	871 (3%)
Other	2,465 (5%)	1,238 (4%)
<i>Age</i>		
65-69	13,254 (27%)	2,581 (8%)
70-74	11,860 (24%)	3,685 (11%)
75-79	11,455 (23%)	5,940 (18%)
80+	12,585 (26%)	20,208 (62%)
<i>Comorbidity score</i>		
1st Quartile	18,821 (38%)	5,305 (16%)
2nd Quartile	15,428 (31%)	7,677 (24%)
3rd Quartile	9,585 (19%)	8,358 (26%)
4th Quartile	5,320 (11%)	11,074 (34%)
<i>Socioeconomic status</i>		
Low	9,221 (19%)	6,385 (20%)
Medium	13,256 (27%)	9,115 (28%)
High	26,677 (54%)	16,914 (52%)

* As of December 31, 2013

Table 2

Mortality rate by time since isolated distal radial fracture.

Time since fracture (years)	Mortality rate
Within same year as fracture	3.4%
1 year after fracture	6.4%
2 years after fracture	7.0%
3 years after fracture	7.3%
4 years after fracture	8.1%
5 years after fracture	8.1%
6 years after fracture	7.4%

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Table 3

Risk of death by patient and treatment factors.

	Hazard ratio (95% CI)	p-value
<i>Sex</i>		
Male§	1	
Female	0.77 (0.75 to 0.79)	<0.001
<i>Race</i>		
White§	1	
African-American	1.04 (0.98 to 1.12)	0.20
Other	0.83 (0.79 to 0.88)	<0.001
<i>Age</i> *		
65-69§	1	
70-74	1.40 (1.33 to 1.47)	<0.001
75-79	2.01 (1.91 to 2.10)	<0.001
80+	4.22 (4.05 to 4.40)	<0.001
<i>Comorbidity score</i>		
1 st Quartile§	1	
2 nd Quartile	1.42 (1.37 to 1.47)	<0.001
3 rd Quartile	2.07 (2.00 to 2.14)	<0.001
4 th Quartile	3.70 (3.58 to 3.83)	<0.001
<i>Fracture treatment</i>		
Non-operative treatment§	1	
Internal fixation	0.73 (0.70 to 0.75)	<0.001
External fixation	0.85 (0.79 to 0.91)	<0.001
Pinning	0.91 (0.86 to 0.96)	0.001

* at time of fracture diagnosis; § reference group; CI, confidence interval.