

Life expectancy following diagnosis of a vertebral compression fracture

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Abstract

Summary The life expectancy of vertebral compression fracture (VCF) patients was evaluated as a function of their treatment. Compared to non-operated patients, the kyphoplasty and vertebroplasty patient cohort had 115% and 44% greater adjusted life expectancy, respectively. Kyphoplasty patients had a 34% greater adjusted life expectancy than vertebroplasty patients.

Introduction Balloon kyphoplasty and vertebroplasty are minimally invasive procedures for the treatment of painful VCFs. This comparative effectiveness study characterized the life expectancy of VCF patients as a function of their treatment.

Methods Life expectancy of VCF patients in the 100% U.S. Medicare dataset (2005–2008) was estimated using a parametric Weibull survival model (adjusted for comorbidities), and compared between operated and non-operated patients as well as between kyphoplasty and vertebroplasty patients. A total of 858,978 patients with a newly diagnosed VCF were identified, including 119,253 kyphoplasty patients (13.9%) and 63,693 vertebroplasty patients (7.4%).

Results Adjusted life expectancy was 85% greater for operated than non-operated patients ($p < 0.001$; 95% confidence interval: 82–89%). Compared to non-operated patients, the kyphoplasty and vertebroplasty patient cohort had 115% ($p < 0.001$; 95% confidence interval: 111–119%) and 44% ($p < 0.001$; 95% confidence interval: 42–47%) greater adjusted life expectancy, respectively. Kyphoplasty patients had a 34% greater adjusted life expectancy than vertebroplasty patients ($p < 0.001$; 95% confidence interval: 31–36%). Across all gender–age groups, the median life expectancy predicted by the parametric Weibull model was 2.2–7.3 years greater for operated than non-operated patients.

Conclusions Statistically significant and substantial differences in life expectancy were observed between the treated and non-treated cohorts in the Medicare population. Among the treated cohorts, patients in the vertebroplasty group experienced less of a survival benefit than those who received kyphoplasty. The results will be a useful basis for future cost effectiveness studies of VCF treatments for the Medicare population.

Keywords Kyphoplasty · Life expectancy · Medicare · Vertebral compression fracture · Vertebroplasty

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Introduction

Vertebral compression fractures (VCFs) due to osteoporosis are associated with pain, loss of function, impaired quality of life, and excess mortality [1, 2]. Most diagnosed VCFs are managed conservatively using medication, bracing, and rest. In addition, minimally invasive surgical procedures, including vertebroplasty and balloon kyphoplasty, have been developed to reduce pain and restore function. Vertebroplasty and balloon kyphoplasty differ in their surgical

technique. During vertebroplasty, polymethylmethacrylate (PMMA) bone cement is percutaneously injected into the compression fracture, whereas in balloon kyphoplasty, an inflatable bone tamp is percutaneously introduced into the fracture to create a bone void prior to injection of bone cement. Surgical treatments for VCFs have now been clinically available for over a decade, and their efficacy has been characterized in cohort [3] and prospective randomized trials [4–7].

Recently, randomized trials of varying design have reported conflicting findings related to efficacy of vertebroplasty [4–6], calling into question the indications for surgical management of VCFs. The randomized trials related to VCFs were performed to better understand the clinical efficacy of surgical management, but their small sample size and selection criteria impede extrapolation to a national population, especially between countries. For example, the largest randomized trial of balloon kyphoplasty enrolled 300 patients from eight European countries into either a surgical treatment or nonsurgical management arm [7]. In contrast, between 2005 and 2008, over 1 million patients were diagnosed with a VCF in the United States Medicare population [8]. Analyses of large administrative datasets permit direct assessment of the comparative effectiveness of different treatments and complement the much smaller clinical trials. Significantly, recent changes in the national health policy of the United States have placed new emphasis on the importance of comparative effectiveness research for assessing the real world performance of clinical interventions [9].

Few comparative effectiveness studies have been reported for surgical interventions following VCF. Zampini and colleagues [10] used the Nationwide Inpatient Sample for 2005 to study hospital outcomes for 5,766 patients treated on an emergent basis for VCF. Emergent VCF patients treated with kyphoplasty were more likely to be discharged to home, and 48% less likely to die in the hospital than non-surgically managed patients [10]. Previous longitudinal comparative effectiveness research on the survival characteristics of the Medicare population following VCF also focused on adjusted mortality risk. After adjusting for covariates, including the presence of comorbidities and the general health status of 858,978 Medicare beneficiaries, surgically managed VCF patients were 37% less likely to die than non-operated controls during the 4-year study period from 2005 to 2008 [8]. However, absolute mortality risk in the terms of a patient's life expectancy is unmeasured. Thus, it is unknown whether the overall 37% reduction in mortality risk represents change in life expectancy of days, months, or years. It is also poorly understood whether certain patient subgroups, such as male octogenarians would experience a significant treatment benefit from surgical management measured in terms of increased life expectancy.

Consequently, the primary objective of the present study was to characterize the life expectancy of VCF patients in the Medicare population as a function of age, gender, and surgical treatment. We examined the null hypotheses that, after controlling for covariates including age, gender, and the presence of comorbidities, (1) surgically managed VCF patients would have no greater life expectancy than non-operated controls; and (2) VCF patients treated by balloon kyphoplasty would have no greater life expectancy than patients treated using vertebroplasty. A second goal of this study was to compare absolute differences in life expectancy, if any, between treated and non-treated cohorts in the VCF Medicare population.

Methods

Patients with a newly diagnosed VCF were identified from the 100% Medicare national inpatient and outpatient claims data between January 1, 2005 and December 31, 2008. The protocol for identifying VCF patients, assigning patients to operated versus non-operated subgroups, and characterizing patient comorbidities was the same as in a previous mortality study [8]. For completeness, the methods for patient identification and classification are summarized below. The life expectancy analytical methods, unique to the present study, are likewise detailed in a separate section.

Patient identification, classification, and comorbidity adjustment

VCF patients were identified using International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) diagnosis codes for vertebral fractures (733.13, 805.0, 805.2, 805.4, 805.6, or 805.8). The full 100% dataset of all Medicare beneficiaries in the U.S. was used. The study was designed to include primarily index fractures by incorporating a 1-year look-back filter. Using the 2004 Medicare dataset, patients were excluded from the study cohort if they were identified as having had a VCF diagnosis or a vertebral augmentation procedure during 2004. Patients younger than 65, those enrolled in health maintenance organizations, and those not enrolled in both Part A (hospital insurance) and Part B (medical insurance) of Medicare were excluded from the analysis. Of the 1,007,070 cases of vertebral fracture identified, 148,092 patients (14.7%) were excluded using the aforementioned criteria, leaving a study population of 858,978 VCF patients (85.3%).

Baseline general health status and specific comorbidity derived health status for each patient were evaluated in the 1-year look-back period. Disease diagnoses from inpatient and outpatient procedures were compiled from the Medicare claims during the 1-year look-back period. To account for

the *general* health status of each patient prior to their VCF, the composite Charlson comorbidity index (Dartmouth–Manitoba version [11]) was calculated. To account for 12 *specific* comorbid conditions that have been previously identified as possible causes of death associated with VCFs [12], the health status of each patient was also determined based on the diagnosis of arterial disease, chronic obstructive pulmonary disease (COPD), cancer, diabetes, hip fracture, hypertension, ischemic heart disease, other heart disease (e.g., conduction disorders), pneumonia, pulmonary heart disease, stroke, or wrist fracture. These were based on the presence of corresponding ICD-9-CM codes [8] in the 12-month period prior to the index VCF event.

VCF patients were stratified into four patient groups: those who had kyphoplasty, those who vertebroplasty, those who had either kyphoplasty or vertebroplasty (“operated”), and those who did not undergo either surgical procedure (“non-operated”) following the VCF diagnosis. Kyphoplasty patients were identified using ICD-9-CM code 81.66 or Current Procedural Terminology, 4th Edition (CPT-4) codes 22289 (only before 2006), 22523, 22524, and 22525. Vertebroplasty patients were identified using ICD-9-CM code 81.65 and CPT-4 codes 22520, 22521, and 22522.

Based on the inclusion criteria for the study, 858,978 patients with a newly diagnosed VCF were identified from the 100% Medicare inpatient and outpatient data between 2005 and 2008. Of these patients, 119,253 underwent kyphoplasty (13.9%) and 63,693 underwent vertebroplasty (7.4%). Together, the combined 182,946 patients in the kyphoplasty and vertebroplasty groups (21.3%) formed the operated cohort. The remaining 676,032 patients formed the non-operated cohort (78.7%). The patient profiles were generally comparable between operated and non-operated patients and between kyphoplasty and vertebroplasty patients [8]. A substantially greater proportion of patients that underwent operative treatment did not receive Medicare premium assistance (89.0%) compared to non-operated patients (83.5%). The distribution in Charlson scores was relatively similar between the patient groups (Table 1). Non-operated patients had significantly lower rates of arterial disease, COPD, cancer, diabetes, hypertension, ischemic heart disease, and pulmonary heart disease compared with

operated patients, but higher rates of hip fracture, pneumonia, stroke, and wrist fracture ($p<0.001$ for all).

Life expectancy analysis

The survival of each patient was measured from the time of VCF diagnosis until death, or censored, if death is not determined by CMS by the end of the study period (December 31, 2008). Differences in the survivorship between non-operated VCF patients and operated VCF patients and between VCF patients who underwent kyphoplasty and those who underwent vertebroplasty were assessed with an adjusted Weibull survival model. The Weibull model [13–15] was well suited for the study patient population because preliminary calculation of the hazard function for the groups of VCF patients indicated that the hazard was highest in year following VCF diagnosis, declined thereafter to 3 years, following which the hazard plateaued. The models were adjusted for age, gender, race, Census region (Northeast, Midwest, South, West), recipient of public support for Medicare premium (state Medicare buy-in), patient health status (general and specific), type of diagnosed fracture (pathologic, traumatic), site of service (inpatient or outpatient), per capita income (based on county of residence), physician specialty (orthopedic surgeon, neurosurgeon, interventional radiologist, others), year of diagnosis, and type of treatment (non-operated vs. operated, kyphoplasty vs. vertebroplasty vs. non-operated).

The Weibull model was used to determine the median life expectancy, i.e., duration following VCF diagnosis when 50% of the initial patient cohort was expected to die, for each patient group for each combination of the 24 covariates listed previously. Separate Weibull models were developed for each of the four patient groups (kyphoplasty, vertebroplasty, operated, non-operated). The median life expectancy for each treatment group (non-operated vs. operated, kyphoplasty vs. vertebroplasty vs. non-operated) was determined based on the weighted average of the median residual life expectancies for all patients in that treatment group (e.g., kyphoplasty patients). The weighting was based on the distribution of the remaining covariates (e.g., race, census region) in that patient group. For example, if the life expectancy for patients of different races were dissimilar, the weighted average life expectancy would factor in the distribution of race within that patient population.

Sensitivity analyses were performed to determine the stability and generalizability of the findings from the Weibull models. The sensitivity analysis investigated whether differences in life expectancy between the study cohorts could be attributed to selection bias arising from differential outcomes. These included analyzing the effects of the various exclusion criteria on the life expectancy. Potential treatment effect modification was investigated based on

Table 1 Charlson score distribution

Charlson score	Non-Operated (<i>n</i> =676,032)	Operated (<i>n</i> =182,946)	Kyphoplasty (<i>n</i> =119,253)	Vertebroplasty (<i>n</i> =63,693)
0	42.5%	43.1%	43.6%	42.1%
1–2	36.2%	36.4%	36.3%	36.6%
3–4	13.4%	13.2%	12.9%	13.6%
≥5	7.8%	7.4%	7.2%	7.8%

the presence of a comorbid condition. Specifically, the adjusted life expectancy was computed for patient subgroups, each consisting of patients having one of the 12 comorbidities considered in the Cox regression. The life expectancy comparisons among specific comorbid conditions were also adjusted for general health status of the patients using the Charlson index. All data and statistical analyses were performed using SAS version 9.2 Release 3 (SAS Institute Inc., Cary, NC).

Results

Based on the parametric Weibull model, the adjusted life expectancy was 85% greater for operated than non-operated patients ($p<0.001$; 95% confidence interval: 82–89%). Compared to non-operated patients, the combined kyphoplasty and vertebroplasty patient cohort had 115% ($p<0.001$; 95% confidence interval: 111–119%) and 44% ($p<0.001$; 95% confidence interval: 42–47%) greater adjusted life expectancy, respectively. Kyphoplasty patients had a 34% greater adjusted life expectancy than vertebroplasty patients ($p<0.001$; 95% confidence interval: 31–36%).

Across all gender–age groups, the median life expectancy predicted by the parametric Weibull model was 2.2 to 7.3 years greater for operated than non-operated patients (Tables 2 and 3). For example, the median life expectancy for 65- to 69-year-old females was 12.7 years following VCF diagnosis for non-operated patients (Table 2), in contrast to 20.1 years for operated patients (Table 2), resulting in a 7.3-year increase in predicted life expectancy for operated female patients (Table 3). For males in the 65–69 year age group, the median life expectancies were 7.6 and 12.7 years for non-operated and operated patients, respectively, resulting in a 5.1-year increase in predicted life expectancy for operated male patients. Patients in the kyphoplasty group had longer median life expectancies than those in the vertebroplasty group (Tables 4 and 5), across all gender–age groups. Females in the 65–69 year age group had median life expectancies of 22.2 years following VCF diagnosis in the kyphoplasty group (Table 4) compared with 17.0 years in the vertebroplasty group (Table 5), resulting in a 5.2-year increase in predicted life expectancy for female kyphoplasty patients (Table 5). For each of the four patient groups (operated, non-operated, kyphoplasty, vertebroplasty), the median life expectancy decreased with age and was also lower for males compared with females. Based on the sensitivity analyses, the differences in the life expectancy between the patient groups were not found to be substantively different when the effects of the exclusion criteria were examined (Tables 3 and 5).

Table 2 Predicted life expectancy (median, 25th percentile, and 75th percentile) (in years) of non-operated and operated patients by age and gender

Age group (years)	Non-operated						Operated					
	Women			Men			Women			Men		
	25th percentile	50th percentile (median)	75th percentile	25th percentile	50th percentile (median)	75th percentile	25th percentile	50th percentile (median)	75th percentile	25th percentile	50th percentile (median)	75th percentile
65–69	4.0	12.7	31.7	2.4	7.6	19.0	6.3	20.1	49.9	4.0	12.7	31.6
70–74	3.5	11.0	27.4	2.1	6.7	16.7	5.7	18.0	44.8	3.6	11.3	28.2
75–79	2.8	9.0	22.3	1.8	5.7	14.2	4.8	15.3	38.0	3.1	9.8	24.4
80–84	2.1	6.6	16.5	1.5	4.7	11.6	3.7	11.8	29.3	2.5	8.0	19.8
≥85	1.2	3.7	9.1	1.0	3.2	7.9	2.2	6.9	17.3	1.7	5.4	13.5

Table 3 Increase in predicted life expectancy (median, 25th percentile, and 75th percentile) (in years) by age and gender for operated, kyphoplasty, and vertebroplasty patients over non-operated patients

Age group (years)	Operated over non-operated						Kyphoplasty over non-operated						Vertebroplasty over non-operated					
	Women			Men			Women			Men			Women			Men		
	25th percentile	50th percentile (median)	75th percentile	25th percentile	50th percentile (median)	75th percentile	25th percentile	50th percentile (median)	75th percentile	25th percentile	50th percentile (median)	75th percentile	25th percentile	50th percentile (median)	75th percentile	25th percentile	50th percentile (median)	75th percentile
65–69	2.3	7.4	18.2	1.6	5.1	12.6	3.0	9.5	23.5	2.0	6.5	16.1	1.3	4.3	10.6	0.9	2.9	7.2
70–74	2.2	7.0	17.4	1.5	4.6	11.5	2.8	8.9	22.2	1.9	5.9	14.6	1.3	4.1	10.3	0.8	2.6	6.5
75–79	2.0	6.3	15.7	1.3	4.1	10.2	2.5	7.9	19.7	1.6	5.2	13.0	1.2	3.7	9.4	0.7	2.3	5.7
80–84	1.6	5.2	12.8	1.0	3.3	8.2	2.0	6.5	16.2	1.3	4.2	10.6	0.9	3.1	7.5	0.5	1.7	4.3
≥85	1.0	3.2	8.2	0.7	2.2	5.6	1.3	4.2	10.6	0.9	3.0	7.5	0.5	1.7	4.4	0.3	1.0	2.6
<i>Without exclusion criteria (sensitivity analysis)</i>																		
65–69	2.3	7.3	18.2	1.7	5.3	13.2	3.0	9.6	24.0	2.1	6.8	17.1	1.3	4.2	10.5	1.0	3.0	7.6
70–74	2.2	6.9	17.2	1.5	4.7	11.8	2.8	8.9	22.1	1.9	6.1	15.2	1.3	4.0	10.1	0.8	2.7	6.7
75–79	2.0	6.2	15.5	1.3	4.2	10.5	2.5	7.9	19.8	1.7	5.4	13.5	1.2	3.7	9.2	0.7	2.3	5.9
80–84	1.6	5.2	12.8	1.1	3.4	8.6	2.1	6.6	16.4	1.4	4.5	11.2	0.9	3.0	7.4	0.6	1.8	4.5
≥85	1.1	3.3	8.3	0.7	2.3	5.8	1.4	4.4	10.9	1.0	3.2	8.0	0.6	1.7	4.4	0.3	1.1	2.7

Table 4 Predicted life expectancy (median, 25th percentile, and 75th percentile) (in years) of kyphoplasty and vertebroplasty patients by age and gender

Age group	Kyphoplasty						Vertebroplasty					
	Women			Men			Women			Men		
	25th percentile	50th percentile (median)	75th percentile	25th percentile	50th percentile (median)	75th percentile	25th percentile	50th percentile (median)	75th percentile	25th percentile	50th percentile (median)	75th percentile
65–69	7.0	22.2	55.2	4.4	14.1	35.1	5.3	17.0	42.3	3.3	10.5	26.2
70–74	6.3	19.9	49.6	4.0	12.6	31.3	4.8	15.1	37.7	2.9	9.3	23.2
75–79	5.3	16.9	42.0	3.4	10.9	27.2	4.0	12.7	31.7	2.5	8.0	19.9
80–84	4.1	13.1	32.7	2.8	8.9	22.2	3.0	9.7	24.0	2.0	6.4	15.9
≥85	2.5	7.9	19.7	1.9	6.2	15.4	1.7	5.4	13.5	1.3	4.2	10.5

Table 5 Increase in predicted life expectancy (median, 25th percentile, and 75th percentile) (in years) by age and gender for kyphoplasty over vertebroplasty patients

Age group	Kyphoplasty over vertebroplasty					
	Women			Men		
	25th percentile	50th percentile (median)	75th percentile	25th percentile	50th percentile (median)	75th percentile
With exclusion criteria						
65–69	1.7	5.2	12.9	1.1	3.6	8.9
70–74	1.5	4.8	11.9	1.1	3.3	8.1
75–79	1.3	4.2	10.3	0.9	2.9	7.3
80–84	1.1	3.4	8.7	0.8	2.5	6.3
≥85	0.8	2.5	6.2	0.6	2.0	4.9
Without exclusion criteria (sensitivity analysis)						
65–69	1.7	5.4	13.5	1.2	3.8	9.4
70–74	1.5	4.8	12.0	1.1	3.4	8.5
75–79	1.3	4.3	10.6	1.0	3.1	7.7
80–84	1.1	3.6	8.9	0.8	2.7	6.6
≥85	0.8	2.6	6.6	0.7	2.1	5.3

Discussion

With a decade of clinical use in the United States, vertebroplasty and kyphoplasty are candidates for comparative effectiveness research in the field of osteoporosis treatments. Prior to 2000, patients were treated via conservative management. As osteoporotic vertebral fractures are most common among the elderly, the clinical history of vertebroplasty and kyphoplasty, as well as nonsurgical treatment, are effectively captured in the claim files of the Medicare program, which covers 38.7 million patients aged 65 years and older in the United States, as well as 7.6 million of the disabled [16]. Thus, the present study using existing large administrative claims files satisfies the criteria for comparative effectiveness research as defined by the 2009 health care reform legislation [17]: we analyzed and directly compared the predicted life expectancy of 858,978 Medicare beneficiaries who received either vertebroplasty, kyphoplasty, or non surgical management following their vertebral fracture between 2005 and 2008. The results of this study indicate that, contrary to the null hypotheses, both statistically significant and substantial differences in life expectancy are observed between the treated and non-treated cohorts in the Medicare population. Among the treated cohorts, patients in the vertebroplasty group experienced less of a survival benefit than those who received kyphoplasty. Although two, much smaller, clinical trials [4, 5] published in the *New England Journal* raise questions about the efficacy of vertebroplasty, the results of the present study underscore the danger of overgeneralizing the findings of vertebroplasty to other surgical treatments of VCFs, such as kyphoplasty.

Excess mortality following vertebral fractures is thought to be due to comorbidities, rather than due to the fracture

itself [1]. The reasons underlying the improved survivorship of the treated cohorts are difficult to elucidate using the administrative claim files alone, but the differences are unlikely to be the result of differences in health status between the patient groups. In the present study, as in previous research [8], we adjusted for the presence of general health status as well as 12 specific comorbidities. Using an instrumental variables approach, we have previously considered the effect of unmeasured selection bias on the adjusted mortality risk following operative and non-operative treatment for vertebral fracture [8]. We have also performed subgroup analyses to explore the sensitivity of the survival benefit experienced by patients in the kyphoplasty and vertebroplasty treated cohorts [8]. Much of the improvement in survivorship following VCF treatment is observed short term, as supported by the inpatient studies by Zampini and colleagues [10]. However, even when we exclude Medicare patients who have survived 1 year beyond their VCF diagnosis, patients in the kyphoplasty cohort continue to exhibit significantly reduced mortality when compared with non-operated patients [8]. For the present study, when we modeled the patient mortality curve following VCF diagnosis for each cohort using a Weibull distribution, the tail of the distribution extended beyond 1 year. Although multiple analyses and sensitivity studies confirm the lasting survival benefit experienced by Medicare beneficiaries in the surgical treatment arms of this study [8], it remains unclear whether the surgical treatment alone, or in combination with heightened care in general for these patients, can explain the observed improved life expectancy following surgical treatment for VCF.

Notwithstanding the importance afforded to comparative effectiveness studies by current changes in health policy

[17], observational studies of administrative claims data are not without limitations. First, study designs of this type may be associated with bias in patient selection, but we have mitigated this limitation to the extent possible with sensitivity studies and instrumental variables analyses to account for unmeasured bias in patient selection [8]. Second, the study design was based on diagnosis of VCF in an outpatient or inpatient setting, and thus does not include the entire population of patients in the United States who were diagnosed with a VCF solely during a physician office visit, nor does it include asymptomatic VCF patients who never seek medical treatment and thus are uncaptured by the Medicare data set. The excluded VCF patients in this study, who were seen exclusively in physician office visits or were asymptomatic, represent “mild” vertebral fractures; the quarter million Medicare beneficiaries diagnosed each year with a VCF in an outpatient or inpatient setting represent more serious VCFs warranting greater medical attention and thus were the focus of the present study. Third, due to the administrative claims nature of the data, we were unable to determine if the non-operated patients had less pain or were too sick to undergo operative treatment. However, we attempted to account for any potential selection bias by considering the patients’ general health status and history of certain comorbidities in the analysis. Fourth, because drug intervention data was not available in the dataset, we were unable to investigate the effects of drug intervention on life expectancy. However, drug intervention alone may not necessarily explain the large observed differences in life expectancy between the treatment groups. Fifth, the Medicare database consists of administrative claims and clinical outcomes that are limited to assessment using ICD-9 diagnoses codes and the presence of procedure codes used to treat complications. Sixth, the present study focused on life expectancy following VCF and did not explore other procedure related outcomes, such as costs or complications (e.g., recurring fractures). To the extent that the treatment arms of the present study experienced differential clinical outcomes following their initial VCF diagnosis and treatment, these outcomes are implicit in the life expectancy analysis. Treatment costs and complications are topics worthy of future research, but were beyond the scope of the present study.

The improvement of life expectancy experienced by surgically managed VCF patients in the current study compares favorably with other pharmaceutical and medical device technologies. Certain chemotherapy drugs, which increase life expectancy on the order of months [18], have been made available to Medicare beneficiaries. Implantable cardioverter defibrillators (ICDs), based on the MADIT II trial, were shown to increase discounted life expectancy by 1.8 years [19]. Depending upon the type of surgical management, as well as the age and gender of the patient, life expectancy increases of up to 9.5 years were estimated for

certain groups of the Medicare patient population diagnosed with a VCF (Table 2).

The development of new technologies to treat disease raises serious economic concerns [18], especially in a post-recessionary period. Historically, surgical and pharmaceutical interventions for the U.S. health care system have judged primarily based on their efficacy rather than their cost effectiveness. However, the unsustainably growing cost of the Medicare program compared to our national economy [16] will eventually demand that not only cost but also cost effectiveness be factored into the widespread adoption of new technologies into the health care system. According to the latest Annual Report of the trustees for the trust fund that finances Medicare [16], “The difference between the current-law and illustrative alternative (Hospital Insurance) projections underscores the importance of finding innovative new methods of delivering and paying for health care that improve quality of outcomes and achieve better cost efficiency.” When reporting the economic implications of greater availability of ICD technology in the *Annals of Internal Medicine*, Al-Khatib and colleagues [19] judged that “the incremental cost-effectiveness ratio associated with [ICD therapy] survival benefit is reasonably favorable (\$50,500 per life-year gained).” Although we did not study the overall treatment costs for surgical treatment of VCFs, Zampini and colleagues [10] have reported that the in-hospital costs for treating VCFs in the United States were \$17,119 greater for kyphoplasty than nonsurgical management (\$37,231 vs. \$20,112). Based on the results of the present study, in which patients in the kyphoplasty cohort experienced greater median life expectancy of 3.0–9.5 years (Table 2), when combined with Zampini’s incremental cost of hospitalization, an approximate cost effectiveness ratio for kyphoplasty can be estimated to range from \$1,802 to \$5,706 per year of life gained (unadjusted), depending upon the age and gender of the patient.

While preliminary, the cost effectiveness of surgical management of VCF Medicare beneficiaries using kyphoplasty compares favorably with the criteria for accepted life extending technologies, such as ICD therapy. Kyphoplasty has previously been found to be cost effective in a U.K. hospital setting [15]. The results of the present study, which characterizes the life expectancy for VCF treated hospital patients and outpatients, will be a useful basis for future cost-effectiveness studies for the Medicare population.

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Conflicts of interest None.

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