MILLIMAN RESEARCH REPORT

Medicare cost of osteoporotic fractures

The clinical and cost burden of an important consequence of osteoporosis

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EXECUTIVE SUMMARY

OSTEOPOROSIS OVERVIEW

Osteoporosis, or porous bone, is a disease characterized by low bone mass and structural deterioration of bone tissue, leading to bone fragility and an increased risk of osteoporotic fractures of the hip, spine, wrist, and other body sites.[1] Osteoporotic fractures are those not caused by high-impact or high-trauma events. A common example is a fracture resulting from a fall from standing height. In the United States, more than 53 million people either already have osteoporosis or are at high risk due to low bone mass.[1] Osteoporotic fractures, which are low-impact bone fractures associated with the weak bones caused by osteoporosis, are costly. The total annual expense of providing care for osteoporotic fractures among Medicare beneficiaries, including direct medical costs as well as indirect societal costs related to productivity losses and informal caregiving, has been estimated by Lewiecki et al. at $57 billion in 2018, with an expected increase to over $95 billion in 2040.[2] The clinical burden of osteoporosis is also significant, with osteoporotic fractures often leading to inpatient hospitalizations,[3] subsequent fractures,[4–6] pressure ulcers,[7] or death.[3]

The burden of osteoporosis may be reduced through both primary and secondary prevention models. Primary prevention includes targeted intervention and treatment programs that aim to improve screening for osteoporosis with bone mineral density (BMD) tests and treatment with pharmacologic agents as well as identifying lifestyle risk factors and encouraging their modification.[8] In terms of secondary prevention, an osteoporotic fracture is a sentinel event that should trigger appropriate clinical attention directed to reducing the risk of future fractures. Increased focus on the identification and management of individuals who have experienced an osteoporotic fracture through a secondary fracture prevention program may lead to reduced rates of subsequent fractures and result in cost savings to payers, such as Medicare.[9]

KEY FINDINGS FROM MILLIMAN'S ANALYSIS

We report on the economic and clinical burden of new osteoporotic fractures that occurred in 2015 in the Medicare fee-for-service (FFS) population using information from a large administrative medical claims database. We focus on "new" osteoporotic fractures by excluding beneficiaries who had another osteoporotic fracture in the prior six- to 12-month period.

Incidence of osteoporotic fractures among Medicare FFS beneficiaries

- Approximately 1.4 million Medicare FFS beneficiaries, or about 4% of the total, suffered over 1.6 million osteoporotic fractures in 2015. Applying the same rate of osteoporotic fractures to Medicare Advantage (MA) beneficiaries would add an additional 700,000 fractures (suffered by 600,000 beneficiaries), for a total of 2.3 million fractures suffered by all Medicare beneficiaries. Financial incentives available to MA plans to improve screening and treatment, as well as differences in population risk characteristics between Medicare FFS and MA beneficiaries, however, may result in a lower fracture rate among MA beneficiaries.
- Fractures of the spine and hip were the most common type of fractures identified, accounting for 40% of all osteoporotic fractures in 2015.
- Female beneficiaries had 79% higher rates of osteoporotic fracture than males, after adjusting for age. Of the 1.4 million Medicare FFS beneficiaries who had at least one osteoporotic fracture in 2015, an estimated 970,000 were women and 410,000 were men.

Key events following a new osteoporotic fracture

- Over 40% of Medicare FFS beneficiaries with a new osteoporotic fracture were hospitalized within one week after the fracture. Of those with a hip fracture, over 90% were hospitalized within a week.
- Only 9% of female Medicare FFS beneficiaries were evaluated for osteoporosis with a BMD test within six months following a new osteoporotic fracture.
- An estimated 205,000 Medicare FFS beneficiaries, or about 15% of those who had a new osteoporotic fracture, suffered one or more subsequent fractures within 12 months of the initial fracture.
- Nineteen percent of Medicare FFS beneficiaries with a new osteoporotic fracture developed at least one pressure ulcer within up to two to three years of the initial fracture.
- Nearly one in five Medicare FFS beneficiaries died within 12 months following a new osteoporotic fracture. This accounted for approximately 260,000 deaths among Medicare FFS beneficiaries who suffered an osteoporotic fracture in 2015. Of these, about 164,000 were female and 96,000 were male. Beneficiaries with a hip fracture had the highest mortality; of Medicare FFS beneficiaries with a hip fracture, 30% died within 12 months of the fracture.

Direct medical cost of fractures

- Total cost following fracture. Annual allowed medical costs to Medicare for beneficiaries in the 12-month period beginning with the new osteoporotic fracture were more than twice the costs incurred in the 12-month period prior to the fracture for the same beneficiaries. The incremental annual medical cost of a new osteoporotic fracture was over $21,800, which included only direct costs identifiable through an administrative medical claims database.
- SNF cost following fracture. The incremental annual medical cost in the year following a new osteoporotic fracture increased substantially for skilled nursing facility (SNF) services (+256%) as compared to the year prior to the fracture, which accounted for about 30% of the total incremental annual medical cost of $21,800.
- Cost of subsequent fracture. The estimated incremental medical cost to Medicare of a subsequent fracture over the 180-day period following a new osteoporotic fracture was over $20,700 (95% confidence interval [CI]: $19,900 to $21,800). An estimated 307,000 Medicare FFS beneficiaries suffered a subsequent fracture during a follow-up period that lasted up to two to three years and survived for at least 180 days after the subsequent fracture, which would account for over $6.3 billion in allowed cost to Medicare FFS (95% CI: $6.1 billion to $6.7 billion).

Potential cost savings from reductions in subsequent fractures

- Preventing between 5% and 20% of subsequent fractures could have saved between $310 million (95% CI: $272 million to $358 million) and $1,230 million (95% CI: $1,076 million to $1,421 million) for the Medicare FFS program during a follow-up period that lasted up to two to three years after a new osteoporotic fracture, based on the historical incidence and treatment patterns of beneficiaries who had an osteoporotic fracture in 2015. This savings estimate includes the cost of performing BMD tests on an additional 10% to 50% of new osteoporotic fracture patients, but does not account for any increased costs of osteoporosis treatment or additional administrative costs of a secondary fracture prevention program.

In the body of this report, we provide additional information on our sample of 49,273 Medicare FFS beneficiaries identified as having a new osteoporotic fracture in 2015. We include findings on the fracture rate by age, the occurrence of key events following an osteoporotic fracture (such as subsequent fractures or death), the estimated cost of a subsequent fracture, and the potential cost savings from increased emphasis on secondary fracture prevention that avoids a percentage of subsequent fractures in Medicare FFS.

Implications for the Medicare program from the findings of this report may include the following.

- Our analysis indicates that the current clinical and economic burden of osteoporosis is high due to osteoporotic fractures.
- The cost of a subsequent fracture after a new osteoporotic fracture is also high. In our analysis, we found that the risk-adjusted incremental cost of a subsequent fracture was over $20,700 (95% CI: $19,900 to $21,800) during the 180-day period following the subsequent fracture. An estimated 307,000 Medicare FFS beneficiaries suffered a subsequent fracture during a follow-up period that lasted up to two to three years and survived for at least 180 days after the subsequent fracture, which would account for over $6.3 billion (95% CI: $6.1 billion to $6.7 billion) in allowed cost to Medicare FFS.
- Preventing a modest percentage of subsequent fractures after a new osteoporotic fracture may lead to Medicare cost savings. We estimated that reductions of 5% to 20% in the rate of subsequent fractures could have led to savings of $310 million (95% CI: $272 million to $358 million) and $1,230 million (95% CI: $1,076 million to $1,421 million) for the Medicare FFS program during a follow-up period of up to two to three years after a new osteoporotic fracture in 2015.

METHODOLOGY

Using administrative medical claims data from a Medicare Limited Data Set (LDS), we identified new osteoporotic fractures, which are those fractures that are newly diagnosed and not associated with a high-trauma event, among a Medicare FFS population in 2015. We analyzed post-fracture medical service utilization and cost, as well as the occurrence of key events such as death or subsequent fractures, for a post-fracture follow-up period that lasted up to two to three years or until death, if earlier.

In addition, we used regression models to quantify the incremental cost of a subsequent fracture. We used the model results, as well as the data from our analysis on the incidence of new osteoporotic fractures, to estimate the potential savings from preventing a percentage of subsequent fractures.

This report was commissioned by the National Osteoporosis Foundation. The findings reflect the research of the authors; Milliman does not intend to endorse any product or organization. If this report is reproduced, it should be reproduced in its entirety, as pieces taken out of context can be misleading. Our analysis is based on historical practice patterns and treatments, which may change over time, and experience may vary from the estimates presented in this report for many reasons. As with any economic or actuarial analysis, it is not possible to capture all factors that may be significant. Further, no algorithm for identifying fragility fractures will be perfect. Because we present national average data, the findings should be interpreted carefully before they are applied to any particular situation because there could be considerable variation among subsets of the population. Two of the coauthors, Bruce Pyenson and Dane Hansen, are members of the American Academy of Actuaries and meet its qualification standards for this work.

INTRODUCTION

The objective of this report is to provide insights into the economic and health impact of osteoporotic fractures on Medicare FFS beneficiaries and the Medicare FFS program. Using medical claims data for a representative population of Medicare FFS beneficiaries, we:

- Identified the incidence of new osteoporotic fractures, which were newly diagnosed fractures that were not associated with a high-trauma event, among a population of Medicare FFS beneficiaries
- Determined the incidence of key events among Medicare FFS beneficiaries after the new fracture, such as BMD tests, acute inpatient hospitalizations, development of pressure ulcers, becoming dual eligible for Medicaid, institutionalization, and death
- Determined the occurrence of subsequent osteoporotic fractures, either of the same body part (i.e., refractures) or of a different body part (new fractures of a different body part)
- Estimated the incremental cost to the Medicare FFS program for subsequent fractures
- Estimated a range of savings to the Medicare FFS program if a percentage of subsequent fractures were avoided

BACKGROUND ON OSTEOPOROSIS

EPIDEMIOLOGY OF OSTEOPOROSIS

Osteoporosis is an important risk factor for fragility or osteoporosis-related fractures in older adults, referred to hereafter as osteoporotic fractures. According to the World Health Organization (WHO), osteoporosis is defined as a BMD that is more than 2.5 standard deviation (SD) units below the mean BMD value for a young adult.[10–12] The WHO also defines low bone mass as a BMD value between one SD unit and 2.5 SD units below the average bone mass for a young adult.[12] Low bone density leads to high susceptibility to osteoporotic fractures,[13] which are fractures not caused by high-impact or high-trauma events. For example, a fracture resulting from a fall from standing height is an osteoporotic fracture.

PREVALENCE OF OSTEOPOROSIS

Recent osteoporosis prevalence estimates showed that more than 10 million adults aged 50 and older had osteoporosis in the United States in 2010, with the majority (77% to 80%) being women.[14,15] Osteoporosis is most common among Mexican-American women (20.4%), non-Hispanic white women (15.8%), and women aged 80 and older (34.9%).[15] Low bone mass is also prevalent, affecting 43.9% of adults aged 50 and older.[15]

Among adults aged 65 and over, who are generally eligible for Medicare coverage, 16.2% had osteoporosis between 2005 and 2010.[16] The average age-adjusted prevalence of osteoporosis was higher among women (24.8%) than men (5.6%), and the prevalence was higher among adults aged 80 and over (25.7%) than among adults aged 65 to 79 (12.8%).[16] Significantly, while Medicare covers effective screening and treatments, Solomon et al. found that the percentage of patients aged 50 and older, with either commercial or Medicare supplemental health insurance, who received a registered therapy for osteoporosis within 12 months of a hip fracture has declined in the United States from 40% in 2002 to 21% in 2011.[17]

CLINICAL AND COST BURDEN OF OSTEOPOROTIC FRACTURES

Looker et al. estimated that 10-year fragility fracture probabilities are 0.9% for fractures of the hip and 7.4% for all major fragility fracture types among adults aged 50 and over.[18] These 10-year probabilities of fracture vary significantly by age (older groups are more likely to have a fracture), sex (women are more likely to have a fracture), and race and Hispanic origin (non-Hispanic white individuals are more likely to have a fracture).[18] Lewiecki et al. project that the count of osteoporotic fractures will grow by 68% between 2018 and 2040 to approximately 3.2 million fractures per year as the Medicare FFS population continues to grow.[2]

Fractures of the hip and spine are prevalent and accounted for 14% and 27%, respectively, of all fragility fractures suffered by individuals in the United States aged 50 years and older.[19] These fractures are typically considered severe and beneficiaries tend to have high morbidity as well as high costs following these fracture events. Research suggests that fractures of the spine are actually under-diagnosed due to a lack of radiographic detection and the use of ambiguous terminology in radiology reports.[20]

The cost of providing fracture care is substantial. Lewiecki et al. estimated that the total annual expense of care for all osteoporosis-related fractures, which included both direct medical costs and indirect costs such as productivity losses and informal caregiving, was $57 billion in 2018.[2] The total cost of fracture care is expected to grow significantly over time due to the aging of the U.S. population, with these researchers estimating an increase in total osteoporosis-related expenses to over $95 billion in 2040, an increase of nearly 70% from $57 billion in 2018.[2] For hip fractures specifically, a recent analysis of 2014 Medicare claims suggested that the direct medical cost of providing care for patients accounted for nearly $6 billion of healthcare spending, or just over $50,000 per hip fracture patient.[21] The cost of providing care for common post-fracture events, including prolonged acute inpatient hospitalizations,[3] additional subsequent fractures,[4–6] and pressure ulcers,[7] may lead to significant increases in the long-term cost of care for individuals with osteoporotic fractures.

Moreover, the burden of osteoporotic fractures on individuals is high. For instance, hip fractures may lead to loss of independence that results in institutionalization in a nursing facility, chronic hip pain, decreased overall health status, and reduced mobility.[22] Individuals may have difficulty performing basic activities of daily living after a fracture,[3] such as cooking.[22] Additionally, hip fractures increase the overall likelihood of subsequent hospitalizations by 231% and increase the likelihood of death by 83% over the following eight years.[3] One study found that over the 10-year period following a hip fracture, the number of subsequent hospitalizations increased by 9.4%, the number of hospital days increased by 21.3%, and the total charges increased by 16.3%.[3]

EFFORTS TO ADDRESS OSTEOPOROSIS

STRATEGIES TO REDUCE BURDEN

The incidence of osteoporosis-related bone fractures may be reduced through osteoporosis intervention and treatment programs designed to identify at-risk individuals, prevent osteoporosis, and provide appropriate treatment and education.[19] BMD tests, the most common of which is called dual-energy x-ray absorptiometry or DXA, can be used to predict an individual's risk for future bone fractures[23] and to target individuals at high fracture risk for treatment. Studies have found that screening for osteoporosis with BMD testing or quantitative ultrasound (QUS) was likely to reduce the incidence of hip fractures.[24,25]

In its June 2018 evaluation of the strength of the evidence for osteoporosis screening, the United States Preventive Services Task Force (USPSTF) updated its recommendation on screening for osteoporosis. As of 2018, the USPSTF now recommends screening for osteoporosis in all women aged 65 and older, and in targeted women younger than 65 years with increased risk of osteoporosis.[26] Previous USPSTF guidelines, originally released in 2002, had recommended routine screening for osteoporosis only in women aged 65 and older, with routine screening beginning at age 60 for women at increased risk for osteoporotic fractures.[27] The 2018 guidelines were updated from 2002 to add recommendations for screening postmenopausal women younger than 65 because new evidence indicated that individual risk for fracture can be estimated using risk assessment tools, which can lead to actions that reduce the likelihood of future fractures for at-risk individuals.[28]

Other organizations have released similar recommendations for those with osteoporosis or osteoporotic fractures, with some organizations also emphasizing improved patient communication, care integration, and risk education for specific populations at high risk of an osteoporotic fracture.[29–32]

Once osteoporosis has been identified, nonpharmacological management includes adequate calcium and vitamin D intake, weight-bearing exercise, smoking cessation, limitation of alcohol and caffeine consumption, and fall-prevention techniques.[33] The goal of pharmacological therapy is to reduce the risk of fracture, with specific treatment recommendations based on different patient characteristics, such as gender, degree of fracture risk, and additional risk factors, such as comorbid diseases or medications.[33] Tu et al. summarized osteoporosis treatment guidelines frequently used in clinical practice, including those of the American Association of Clinical Endocrinologists and American College of Endocrinology (AACE/ACE), the North American Menopause Society (NAMS), the Endocrine Society, the American College of Rheumatology (ACR), the National Osteoporosis Foundation (NOF), and the American College of Physicians (ACP).[33] While noting some differences, they concluded that the guidelines present a relatively consistent set of recommendations for the diagnosis and initiation of osteoporosis treatment.[33]

TRENDS IN OSTEOPOROSIS SCREENING, TREATMENT, AND OSTEOPOROTIC FRACTURES

Some evidence suggests the use of bone density tests for screening and identification of at-risk individuals is low and may be declining. The testing rate of women aged 65 and older who were covered by Medicare FFS grew between 1996 and 2008, with the annual change in the rate of BMD tests increasing by 6.5% between 2003 and 2006.[34] However, growth in the testing rate for osteoporosis among female Medicare FFS beneficiaries plateaued in 2009 and declined by 3.7% in 2010, when only 14.1% of the beneficiaries were tested.[34] In 2011, King et al. speculated that reductions in Medicare Part B reimbursement for DXA screening in a physician's office beginning in 2007, which may have led to closure of office-based DXA centers, led to declining rates of screening for osteoporosis; this overall decline in testing was despite an increase in DXA scans in the hospital outpatient department.[34] However, in 2011, the Patient Protection and Affordable Care Act (ACA) removed a barrier to bone density testing, along with other preventive services, by eliminating cost sharing for beneficiaries who qualify (§ 4101) and partially restored payment for DXA to its 2006 level during 2010 and 2011 (§ 3111).[35] Since these Medicare FFS payment changes, no analysis has been published on trends over the past decade in the rate of BMD testing for beneficiaries covered under Medicare FFS.

For MA plans, the overall star rating provides a metric of each plan's quality and performance. Each star metric is very specific, and the metrics fall into several domains of care, including the management of chronic (long-term) conditions.[36] A plan's overall star rating is the basis for its quality bonus payment from the Medicare program.[37] The Healthcare Effectiveness Data and Information Set (HEDIS), a collection of widely referenced healthcare performance measures maintained by the National Committee for Quality Assurance (NCQA), is the primary methodology source for a number of MA plan star rating measures.

HEDIS currently maintains two quality measures of BMD testing for osteoporosis screening: osteoporosis testing in older women and osteoporosis management in women who had a fracture.[38,39] The post-fracture osteoporosis testing and management measure is an MA star rating measure in the domain of chronic condition management. Performance data are collected through administrative claims on the percentage of women aged 67 to 85 who suffered a fracture and had either a bone measurement test or treatment for osteoporosis in the six months after the fracture.[40] A notable limitation of this measure is that MA plans may earn credit for screening without providing appropriate follow-up treatment through pharmacological therapies like bisphosphonates, denosumab, and anabolic agents.

For screening or treatment following a fracture, the rates during this measure's first four years in the HEDIS measure set (2007 through 2010) showed almost no improvement.[41] However, rates increased about 9% for MA plans nationally between 2014 (35.9%) and 2017 (44.9%).[41] Nevertheless, general utilization of bone mass measurement in MA is relatively low. Overall osteoporosis two-year screening rates were 19.6%, 26.8%, and 12.9% among women aged 50-64, 65-79, and 80+, respectively, enrolled in MA plans between 2008 and 2014.[42]

An analysis of FFS Medicare data indicated that the annual incidence of osteoporotic hip fractures among women aged 65 and older in Medicare declined by 18% between 2002 and 2012.[43] This decrease in fracture rate was attributed to an increase in the awareness of the risk of falls, lifestyle improvements (such as diet and exercise), and advancements in screening and treatment for osteoporosis.[21,43,44] However, more recently, Lewiecki et al. found that age-adjusted fracture incidence stopped declining and plateaued between 2013 and 2015.[43] They estimated that this plateau resulted in more than 11,000 additional estimated hip fractures between 2013 and 2015, an excess cost of over $459 million to Medicare, and over 2,000 excess deaths within a year of the fracture.[43] Lewiecki et al. hypothesized that reductions in Medicare reimbursement for office-based DXA screening, as well as a declining use of medications known to reduce fracture risk, may have led to this plateau in fracture incidence.[43]

OSTEOPOROTIC FRACTURE PREVENTION PROGRAMS

The financial, societal, and individual cost of the current and potential high future burden of osteoporotic fractures provides the backdrop for an interest in strategies that may reduce the long-term economic and clinical burden of osteoporosis. Primary fracture prevention models are designed to proactively reduce the burden of fractures through screening and identification of individuals at risk for osteoporotic fractures and/or osteoporosis.[8] Osteoporosis screening strategies may include both mass screening using BMD tests and prescreening strategies such as the Fracture Risk Assessment Tool (FRAX), a commonly accessed measure that uses 10 clinical risk factors to predict the 10-year probability of hip fractures or other major osteoporotic fractures and includes country-specific adaptations.[45] Other risk assessment tools for osteoporosis include the Simple Calculated Osteoporosis Risk Estimation (SCORE), the Osteoporosis Risk Assessment Instrument (ORAI), the Osteoporosis Self-assessment Tool (OST), or the Osteoporosis Index of Risk (OSIRIS) risk indices.[46] Of these, the simplest tool is the OST, which estimates risk based on age and body weight alone, while the other tools estimate fracture risk based on additional risk factors, such as fracture history.[47] Other primary prevention approaches focus on improvements in lifestyle and behavior risk factors like exercise,[48,49] calcium and vitamin D intake,[50] and tobacco usage.[51]

In contrast, secondary fracture prevention models, which include fracture liaison service models of care, aim to improve screening and treatment of individuals following an osteoporotic fracture, as they are the individuals at highest risk of subsequent fractures. Common key elements of these models include:

- Integrated care systems
- Provider cost-saving incentives

- Improved awareness and education of patients, providers, and policymakers
- Governmental influence on the creation of national evidence-based guidelines
- Other care initiatives, such as wide availability of management algorithms, nurse coordination of care, and task management disease registry software[9]

Research has focused on the ability of secondary fracture prevention models to improve rates of BMD testing, osteoporosis treatment initiation, treatment adherence, and reduction in rates of refracture and mortality.[52] For example, a systemic review of research studies looking into the effectiveness of fracture liaison service (FLS) programs found that, compared with patients under usual care, patients receiving care under an FLS model received higher rates of BMD testing (48.0% vs. 23.5%), treatment initiation (38.0% vs. 17.2%), and adherence (57.0% vs. 34.1%).[52] Reductions in absolute risk of refracture (-5%) and mortality (-3%) were also observed among individuals aged 50 and older with osteoporotic fractures, relative to control populations without intervention.[52] Another study found that implementation of an FLS program in open healthcare systems increased the percentage of patients receiving BMD testing from 21% at baseline to 93%, with significantly higher levels of prescribed calcium, vitamin D, or pharmacologic treatment.[53]

MODELS OF OSTEOPOROTIC FRACTURE PREVENTION IN THE UNITED STATES

Evidence on the outcomes of secondary fracture prevention models of care throughout the United States is limited. Some examples of U.S.-based models that incorporate secondary prevention include Geisinger Health System's osteoporosis diagnosis management program, Kaiser Permanente's Healthy Bones program, and the Own the Bone program of the American Orthopaedic Association (AOA). These organizations have implemented programs designed to improve quality of and access to fracture-related care.[54]

Geisinger's high-risk osteoporosis clinic (HiROC) fracture liaison service model of care aims to increase awareness, diagnosis, and treatment of osteoporosis by implementing care pathways for four patient groups; one pathway was for patients with a fracture.[55] Since the mid-1990s, this program has led to high levels of intervention among individuals at high risk of fractures, including enhanced consultative services and longitudinal care in both inpatient and outpatient sites of service.[56] Prescription treatment rates under HiROC were 75.4% among drug-eligible patients, compared to only 13.8% of patients in primary care.[56] Between 2006 and 2010, the percentage of women aged 65 and older with a Geisinger primary care physician who had a BMD test within the prior three years increased from 40% to 74%.[55]

Kaiser's Healthy Bones program demonstrated a reduction of over 40% in the expected number of hip fractures in 2009 through the implementation of a program to identify high-risk individuals (those who had a hip fracture or were age 70 or older with any prior fragility fracture) and provide additional DXA screenings and appropriate osteoporosis treatment, resulting in cost savings and improvements in patient well-being.[57] Through outreach programs to target at-risk individuals for BMD tests, an osteoporosis education program, and practice-wide guidelines, Kaiser achieved increases in the utilization of bone mass measurement and medication adherence, and reductions in the expected number of hip fractures.[58] The program reported an increase of 247% in annual BMD tests (from 21,557 to 74,770) in the first four years of the program among more than 620,000 patients, including males and females at risk for fragility fractures.[58]

AOA's Own the Bone program focuses on preventing fragility fractures and increasing appropriate osteoporosis treatment in 177 sites across the United States by changing physician and patient behavior.[59] Own the Bone includes 10 measures designed to improve fracture care, focused on nutritional counseling, physical activity counseling, lifestyle counseling, pharmacotherapy, BMD testing, and physician-patient communication.[59]

Evaluation of the Own the Bone program indicated that these secondary prevention efforts by sites participating in the program led to high rates of BMD testing and osteoporosis pharmacotherapy in patients aged 50 and older following a fragility fracture, with over 60% of patients treated for osteoporosis after a fragility fracture in 2015.[60] Further, Own the Bone reported higher treatment rates for osteoporosis following a fragility fracture than MA plans; the rate of BMD testing and/or pharmacologic therapy in Own the Bone programs was higher than the 90th-percentile of the post-fracture osteoporosis testing and management HEDIS measure results from 2012 to 2015.[60]

Additionally, a pilot study that evaluated implementation of FLS models of care among three open healthcare systems in the United States found that secondary prevention efforts assisted by a cloud-based tool led to significant improvements in the screening and treatment of patients within six months of a newly diagnosed fracture.[53] The FLS program increased the percentage of fracture patients receiving a BMD test within six months of fracture from 21% at baseline to 93% following implementation of the FLS, with those being prescribed pharmacologic treatment for osteoporosis within six months of fracture increasing from 20% to 54%.[53] Through a micro-simulation analysis of fracture outcomes, life expectancy, and osteoporosis-related costs among patients with a hip fracture in the United States, Solomon et al. estimated that an FLS program would result in 153 fewer fractures and savings of over $66,000 per 10,000 post-fracture patients.[61]

Despite these and other reported successes of secondary fracture prevention programs in increasing the rate of BMD testing and treatment and reducing the occurrence of secondary fractures in the United States, as well as USPSTF and NCQA recommendations and measurements on post-fracture osteoporosis testing and treatment, secondary fracture prevention programs have not been widely or uniformly implemented. Further research is needed to determine whether the methods of programs such as those presented above are scalable such that they can reduce the rate of subsequent fractures and generate cost savings among individuals who have experienced an osteoporotic fracture.[53]

INTERNATIONAL MODELS OF OSTEOPOROTIC FRACTURE CARE

Programs focused on improved fracture care have been implemented in numerous countries internationally, with modest success. However, the efficacy of these programs is variable and there is a lack of consensus in the literature on the cost-effectiveness and clinical results of osteoporosis management programs. The variability of results from these programs may be due to the healthcare system in the country, including whether there is a national payer and whether goals of the payers and providers are aligned. In several of these countries in which payers and providers have aligned incentives, successful osteoporosis management programs have demonstrated cost savings and a reduction in the incidence of subsequent fractures. For example:

- In Australia, a targeted intervention reduced refracture risk by 80% over a four-year period in patients with minimal trauma non-vertebral osteoporosis-related bone fractures. The intervention program included a clinic in which patients were treated and subsequently reviewed. Treatment included medications, physical examinations, follow-up questionnaires, and BMD tests along with other laboratory tests.[62] A follow-up study found that an FLS model of care was a cost-effective strategy to reduce fragility fractures and improve quality of life but noted that the high costs of the intervention were only partially offset by a reduction in subsequent fractures.[63]
- In France, an FLS program resulted in decreased incidence of refractures by 70% over 30 months following a patient’s new fracture in a population of patients aged 75 years and older with a new fracture of the hip, shoulder, vertebra, pelvis, or wrist. Designed to reduce the risk of subsequent fractures, this osteoporosis management program provided BMD testing, nutritional assessments, and physical rehabilitation to patients.[64]
- In the United Kingdom, the proportion of secondary hip fractures remained stable between 2003 and 2012 following the implementation of an FLS model of care in 2003 for patients identified with a primary hip fracture. While the program demonstrated potentially cost-effective strategies, which included patient support and improved quality of care, low levels of patient adherence to bisphosphonate therapy contributed to the model’s ineffectiveness in reducing the risk of subsequent hip fractures.[65]

  Other studies have indicated that FLS programs in the United Kingdom were cost-effective in the prevention of subsequent fragility fractures and would lead to increases in the number of avoided fractures.[66] In a modeled cohort of 1,000 fragility fracture patients, 18 secondary fractures were avoided, leading to approximately $34,000 over the lifetimes of 1,000 patients (converted from GBP to USD using exchange rate as of the publication of the referenced study).[66]

- In Canada, an Osteoporosis Exemplary Care Program (OECP) implemented in Toronto in 2002 provided secondary preventive fracture care to patients managed in inpatient and outpatient settings. Through an education and treatment program, more than 95% of patients with an osteoporotic fracture were appropriately diagnosed, treated, or referred for osteoporosis care.[67] A follow-up analysis of the OECP found that an osteoporosis coordinator could reduce the number of subsequent hip fractures, resulting in a net savings.[68]

RESULTS

An analysis of a representative sample of Medicare claims identified all claims related to new osteoporotic fractures in 2015. We refer to new fractures that were not associated with a high-trauma event, thus assumed to be due to bone fragility, as “new osteoporotic fractures.”

The claims analyses provided information on the demographic characteristics and medical costs of 49,273 Medicare FFS beneficiaries who had new osteoporotic fractures in 2015. The analysis included the incidence of new osteoporotic fractures by type (or region of the body), the occurrence of subsequent events of interest following a fracture, and related healthcare costs during episodes of care that began with an osteoporotic fracture in 2015 and continued for up to two to three years or until death (i.e., until the earlier of December 31, 2017, or death). We refer to this period of time as the “osteoporotic fracture episode.”

Our analysis was limited to Medicare FFS beneficiaries with both Part A and Part B coverage and did not include those individuals with only Part A coverage. We refer to the population we analyzed as the “Medicare FFS” population in our analysis.

Appendices A, B, and C provide details about the data sources, methodology, and code sets used in this analysis. Appendix D provides supplemental data summaries. Appendix C and Appendix D can be found in supplemental materials and are available online.

OSTEOPOROTIC FRACTURE INCIDENCE

The incidence of new osteoporotic fractures was determined for 10 regions of the body (i.e., fracture types). In total, 441.7 new osteoporotic fractures per 10,000 beneficiaries were identified in 2015 (Figure 1). A beneficiary’s first new osteoporotic fracture in 2015 was used as the trigger event for the analysis that followed, including our analysis of subsequent osteoporotic fractures.

Extrapolating our calculated fracture rate for Medicare beneficiaries with both Parts A and B coverage, this fracture rate translates into an annual fracture incidence of over 1.6 million osteoporotic fractures among the 37 million Medicare FFS beneficiaries in 2015, which includes beneficiaries with only Part A coverage (Figure 1).[69] Applying the same incidence rate to the 16 million MA beneficiaries[69] would add approximately 700,000 fractures, bringing the total to over 2.3 million fractures among Medicare beneficiaries in 2015. We note that the MA plan incentives of star ratings to improve post-fracture osteoporosis testing and treatment for women may lead to improved osteoporosis management and thus lower overall fracture incidence in MA. In addition, other differences between the Medicare FFS and the MA populations, such as differences in the prevalence of chronic conditions, could affect the rate of osteoporotic fractures. Conversely, the absence of Part B coverage for physician care and laboratory testing may imply that beneficiaries with only Part A coverage (which were not included in this analysis) could have a higher overall fracture incidence.

FIGURE 1: INCIDENCE OF NEW OSTEOPOROTIC FRACTURES AMONG MEDICARE FFS BENEFICIARIES BY FRACTURE TYPE IN 2015

FRACTURE TYPE	NEW OSTEOPOROTIC FRACTURE RATE PER 10,000 MEDICARE FFS BENEFICIARIES	ESTIMATED ANNUAL OSTEOPOROTIC FRACTURE CASES IN 2015 (000S)*	PERCENT OF ANNUAL OSTEOPOROTIC FRACTURE CASES IN 2015
Hip	76.1	280	17%
Distal Femur Shaft/Distal Femur	31.7	120	7%
Pelvis/Sacrum	25.8	100	6%
Tibia/Fibula	44.3	170	10%
Humerus	41.2	150	9%
Radius/Ulna	19.4	70	4%
Distal Radius/Ulna	39.7	150	9%
Clavicle	9.7	40	2%
Spine	102.1	380	23%
Rib	51.9	190	12%
Total	**441.7**	**1,650**	**100%**

*Note: Estimated by extrapolating our calculated fracture rate for Medicare beneficiaries with both Parts A and B coverage among the 37 million Medicare FFS beneficiaries in 2015.[69]

These results are generally consistent with a recent study, in which Lewiecki et al. that found the annual incidence of hip fractures was approximately 73.0 per 10,000 Medicare beneficiaries in 2015.[43] Amin et al. also found that the incidence of all fractures was approximately 401.7 per 10,000 annually over a three-year period between 2009 and 2011.[70]

Osteoporotic fractures of the spine and hip were the most common types of fracture, representing 40% of the estimated total annual osteoporotic fractures in 2015, with hip fractures accounting for 17% and spine fractures accounting for 23% of all fractures (Figure 1 above). Our estimate of spinal fracture incidence, which relies upon diagnosis codes on medical claims, has not been adjusted for the potential underdiagnosis of vertebral fractures. Total vertebral fracture incidence would include both clinical or symptomatic and morphometric or radiographic vertebral fractures. Prior research found that hip and spine fractures accounted for 14% and 27%, respectively, of all osteoporosis-related fractures, [19] similar to our results.

> Medicare FFS beneficiaries had over 1.6 million new osteoporotic fractures in 2015. Ignoring potential differences in risk characteristics and medical management between Medicare FFS and Medicare Advantage, applying the same incidence rate to Medicare Advantage beneficiaries would bring the total to over 2.3 million new osteoporotic fractures.

The incidence of new osteoporotic fractures identified in the Medicare FFS population differed substantially by sex, age, institutionalized status (i.e., beneficiaries residing in long-term nursing facilities), and dual eligibility (i.e., beneficiaries eligible for both Medicare and Medicaid benefits). The rate of new osteoporotic fractures per 10,000

Medicare beneficiaries was, as expected, higher in beneficiaries who were female, institutionalized, or older (Figure 2).

FIGURE 2: INCIDENCE OF NEW OSTEOPOROTIC FRACTURES AMONG DIFFERENT SUBSETS OF THE MEDICARE FFS POPULATION IN 2015

POPULATION SUBSET	NEW OSTEOPOROTIC FRACTURE RATE PER 10,000	ESTIMATED BENEFICIARY COUNT WITH AT LEAST ONE NEW OSTEOPOROTIC FRACTURE IN 2015 (000S)
Total Population	**441.7**	**1,380**
Sex		
Male	283.2	410
Female	571.0	970
Age Band		
<65	281.7	140
65-74	276.7	410
75-84	554.8	460
85+	1,043.8	370
Institutionalized Status as of January 2015		
Institutionalized	790.8	70
Non-Institutionalized	431.0	1,310
Dual Status as of January 2015		
Dual Eligible	502.5	180
Non-Dual Eligible	433.9	1,200
Beneficiary Type		
Non-Cancer/Non-ESRD Beneficiaries	409.2	1,000
Beneficiaries with ESRD	749.1	30
Beneficiaries with Non-Metastatic/Non-Bone Cancer	503.6	270
Beneficiaries with Metastatic or Bone Cancer	712.7	80

After adjusting for differences in age, the overall osteoporotic fracture rate for female Medicare FFS beneficiaries was 79% greater than the fracture rate for males. Beneficiaries aged 85 and older had substantially higher sex-adjusted rates of osteoporotic fractures than any other age group of beneficiaries; the rate of osteoporotic fracture was well over double the average national rate. Beneficiaries aged less than 65, who were likely eligible for Medicare on the basis of disability or end-stage renal disease (ESRD),[71] had slightly higher sex-adjusted fracture rates than beneficiaries aged 65 to 74. These fractures may be associated with the conditions that caused their disabilities. Analysis by the Medicare Payment Advisory Commission (MedPAC) found that beneficiaries with ESRD are a high-cost subpopulation.[72] We found these beneficiaries with ESRD have a high rate of osteoporotic fractures, with 749.1 fractures per 10,000 beneficiaries. The age- and sex-adjusted new osteoporotic fracture rate for institutionalized beneficiaries (i.e., those in nursing homes) was 75% greater than the national average rate.

Approximately 1.4 million Medicare FFS beneficiaries suffered at least one osteoporotic fracture in 2015. Of these, the majority were female (970,000 beneficiaries, or 70% of all who had at least one osteoporotic fracture). About one in three beneficiaries who suffered at least one osteoporotic fracture in 2015 were aged 74 to 85 years (460,000 beneficiaries).

BONE MINERAL DENSITY TESTING FOLLOWING A FRACTURE

We found that 21% of Medicare FFS beneficiaries who had a new osteoporotic fracture received a BMD test during their osteoporotic fracture episodes. Our analysis of medical claims data indicated that only 9% of female Medicare FFS beneficiaries received a BMD test within six months following a new osteoporotic fracture. For female beneficiaries aged 65 to 74, this is only slightly higher (14%). We did not measure pharmaceutical treatment for osteoporosis after a new osteoporotic fracture due to the unavailability of Part D claims in our data source, nor did we exclude beneficiaries who died within the follow-up period, so our analysis does not present a full picture of the overall rate of BMD testing and appropriate treatment after a fracture for surviving patients.

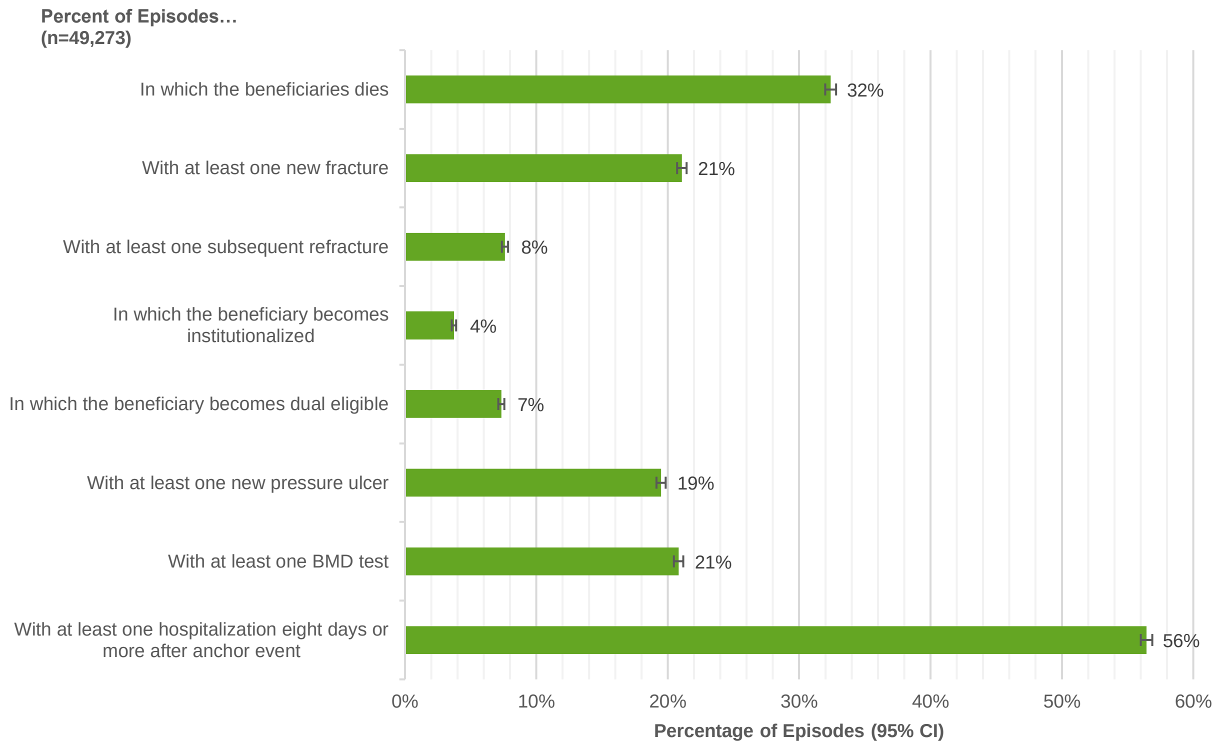
Data from the National Committee for Quality Assurance (NCQA) provides the testing or treatment rates in women enrolled in health plans who had a fracture.[40] By achieving a high rate of osteoporosis testing and/or treatment following a woman's fracture, Medicare Advantage (MA) plans may earn a higher overall star rating. For 2019, plans that test or treat for osteoporosis within six months after a fracture in at least 78% of women enrollees aged 67 to 85 who suffer a fracture earn credit for the highest level of performance (i.e., five stars) on this measure, which contributes to the overall star rating.[73] Plans that earn an overall star rating of four or higher are eligible to receive a quality bonus payment. Since 2007, osteoporosis testing or treatment has improved in MA plans. In 2017, 47% and 39% of women received BMD testing or osteoporosis treatment within six months after a fracture across Medicare health maintenance organization (HMO) and Medicare preferred provider organization (PPO) plans, respectively.[40] While improved, the overall MA plan rate remains below the rate of performance on other MA plan measures of secondary prevention, such as the 90% performance observed on the HEDIS measure, "Persistence of Beta-Blocker Treatment after a Heart Attack."[74]

The HEDIS healthcare performance measure, "Osteoporosis Management in Women Who Had a Fracture," evaluates the proportion of women aged 65 to 85 who received appropriate evaluation or treatment (i.e., BMD test or prescription for a drug to treat osteoporosis) in the six months after a fracture and is an MA plan star rating measure, contributing to an overall rating of the plan's quality and performance.[75] Osteoporosis treatment is defined by the NCQA as a BMD test or a prescription for a drug used to treat osteoporosis.[40] Because our analysis did not include a review of Medicare Part D claims, we were not able to determine the rate at which those who suffered an osteoporotic fracture were treated with a U.S. Food and Drug Administration (FDA)-approved prescription drug therapy for osteoporosis or bone loss covered under Part D. Additionally, the HEDIS measure excludes beneficiaries who die within the six-month period following a fracture, as well as certain beneficiaries who are institutionalized, those with frailty, those in hospice, those with advanced illness, and those with a BMD test within the prior 24-month period; we did not apply these exclusions in our analysis. Therefore, results from our analysis on the proportion of individuals tested or treated for osteoporosis within six months of a fracture cannot be directly compared to the HEDIS performance measurement results.

SUBSEQUENT EVENTS FOLLOWING FRACTURE

Analysis of Medicare claims data demonstrates the significant and costly impact of osteoporotic fractures on Medicare beneficiaries. Fracturing a bone, most often related to underlying osteoporosis, leads to a host of negative and costly health consequences, including hospitalization, additional bone fractures, institutionalization, and death. Figure 3 shows the proportion of beneficiaries who had key post-fracture events during their osteoporotic fracture episodes, which extended from their new osteoporotic fractures in 2015 through December 31, 2017, or until death if earlier.

FIGURE 3: PROPORTION OF MEDICARE FFS BENEFICIARIES WITH A NEW OSTEOPOROTIC FRACTURE IN 2015 WHO HAD KEY POST-FRACTURE EVENTS DURING THEIR OSTEOPOROTIC FRACTURE EPISODES



Note: Metrics were not adjusted for key events, other than death, to exclude beneficiaries who died during the osteoporotic fracture episode from the denominator of the proportions (i.e., beneficiaries were not required to survive for the length of the osteoporotic fracture episode). Confidence intervals for the proportion of beneficiaries who had key post-fracture events during their osteoporotic fracture episodes were calculated based on the mean and standard deviation of the sampling distribution of each proportion.

The following subsections describe these findings in more detail.

Hospitalizations

Nearly half (45%) of beneficiaries experienced at least one acute inpatient stay within 30 days of their new osteoporotic fractures.

The percentage of individuals who were hospitalized following a fracture varied widely by fracture type and time elapsed since the new osteoporotic fracture. Ninety-two percent of Medicare FFS beneficiaries with a new osteoporotic fracture of the hip were hospitalized within seven days, while only 11% of those with a new osteoporotic fracture of the distal radius/ulna (i.e., wrist) were hospitalized within seven days (Figure 4).

FIGURE 4: PERCENTAGE OF MEDICARE FFS BENEFICIARIES WITH A NEW OSTEOPOROTIC FRACTURE WHO HAD AT LEAST ONE ACUTE INPATIENT HOSPITALIZATION DURING THE OSTEOPOROTIC FRACTURE EPISODE, BY TIME AFTER FRACTURE EVENT

FRACTURE TYPE	0-7 DAYS AFTER FRACTURE EVENT	8+ DAYS AFTER FRACTURE EVENT*
Hip	92%	59%
Distal Femur Shaft/Distal Femur	62%	60%
Pelvis/Sacrum	57%	60%
Tibia/Fibula	28%	51%
Humerus	29%	56%
Radius/Ulna	13%	47%
Distal Radius/Ulna	11%	45%
Clavicle	20%	54%
Spine	35%	61%
Rib	28%	58%
Total	**42%**	**56%**

* Adjusted for beneficiary mortality prior to the beginning of the event period. Beneficiaries who died prior to the start of the event period were excluded from the denominator of the percentage.

Forty-two percent of Medicare FFS beneficiaries were hospitalized within the seven days following a new osteoporotic fracture. Beneficiaries with fractures of the hip, distal femur, or pelvis had the highest likelihood of hospitalization immediately following their fracture.

See Appendix D for additional information on the most common Medicare Severity Diagnosis Related Groups (MS-DRGs) for acute inpatient hospitalizations following an osteoporotic fracture.

Over 40% of Medicare FFS beneficiaries were hospitalized within a week following a new osteoporotic fracture. Of beneficiaries with a hip fracture, 92% were hospitalized within a week.

Subsequent osteoporotic fractures

We found that over 200,000 Medicare FFS beneficiaries, or 15% of beneficiaries who had a new osteoporotic fracture, had a subsequent fracture either of the same body part (refracture) or of a different body part (new fracture) during the osteoporotic fracture episode. The age- and sex-adjusted one-year rate of subsequent fractures among beneficiaries who had a new osteoporotic fracture (1,367.9 per 10,000 beneficiaries who had a new osteoporotic fracture) was over three times the one-year rate of new osteoporotic fractures among Medicare FFS beneficiaries in 2015 (441.7 per 10,000 beneficiaries). These findings confirm those from other studies that an osteoporotic fracture identifies individuals at increased risk of subsequent fractures.[5,6] For example, Lindsay et al. found that a vertebral fracture increases the risk of a subsequent vertebral fracture fivefold in the following year compared with the incidence of vertebral fracture among individuals without prevalent vertebral fractures at baseline.[76] Similarly, van Geel et al. found that the relative risk of subsequent fracture was 5.3 within one year of an initial clinical fracture among women aged 50 to 90 years.[77]

The table in Figure 5 provides the percentage of Medicare FFS beneficiaries with a new osteoporotic fracture who had a subsequent fracture within 12 months of the new osteoporotic fracture, split into re-fractures of the same (or potentially same) body part and new fractures of body parts other than the body part fractured in the new osteoporotic fracture, by new osteoporotic fracture type.

FIGURE 5: PERCENTAGE OF MEDICARE FFS BENEFICIARIES WITH A NEW OSTEOPOROTIC FRACTURE WHO HAD SUBSEQUENT FRACTURES WITHIN 12 MONTHS OF THE FRACTURE EVENT, BY FRACTURE TYPE

FRACTURE TYPE	ESTIMATED BENEFICIARY COUNT WITH SUBSEQUENT FRACTURES FOLLOWING A NEW OSTEOPOROTIC FRACTURE IN 2015 (000S)	ANY SUBSEQUENT FRACTURE	REFRACTURE OF THE SAME BODY PART	NEW FRACTURE OF DIFFERENT BODY PART
Hip	47	19%	2%	17%
Distal Femur Shaft/Distal Femur	8	18%	2%	16%
Pelvis/Sacrum	15	20%	2%	19%
Tibia/Fibula	14	9%	2%	7%
Humerus	20	15%	2%	13%
Radius/Ulna	9	17%	1%	16%
Distal Radius/Ulna	17	14%	1%	13%
Clavicle	5	15%	2%	14%
Spine	51	15%	6%	9%
Rib	21	12%	2%	11%
Total	**205**	**15%**	**3%**	**12%**

Note: Beneficiaries who died within 12 months of a new osteoporotic fracture were not excluded from the denominator of the percentages (i.e., beneficiaries were not required to survive for 12 months following their initial osteoporotic fracture).

Other researchers have found similar results, observing 10% of female Medicare beneficiaries on average have a subsequent fracture within 12 months following an initial fracture.[78]

We found that fractures of the hip or spine were the most common type of subsequent fractures, except for beneficiaries with new osteoporotic fractures of the hip and radius/ulna. For beneficiaries with new osteoporotic fractures of the hip, subsequent fractures of the distal femur shaft/distal femur were the most common; 10% of beneficiaries with a new osteoporotic fracture of the hip had a subsequent distal femur shaft/distal femur fracture. For beneficiaries with new osteoporotic fractures of the radius/ulna, subsequent fractures of the humerus were the most common; 6% of beneficiaries with a new osteoporotic fracture of the radius/ulna had a subsequent humerus fracture.

The age-sex adjusted one-year rate of subsequent fractures among beneficiaries who had a new osteoporotic fracture was over three times the one-year rate of new osteoporotic fractures for all Medicare FFS beneficiaries.

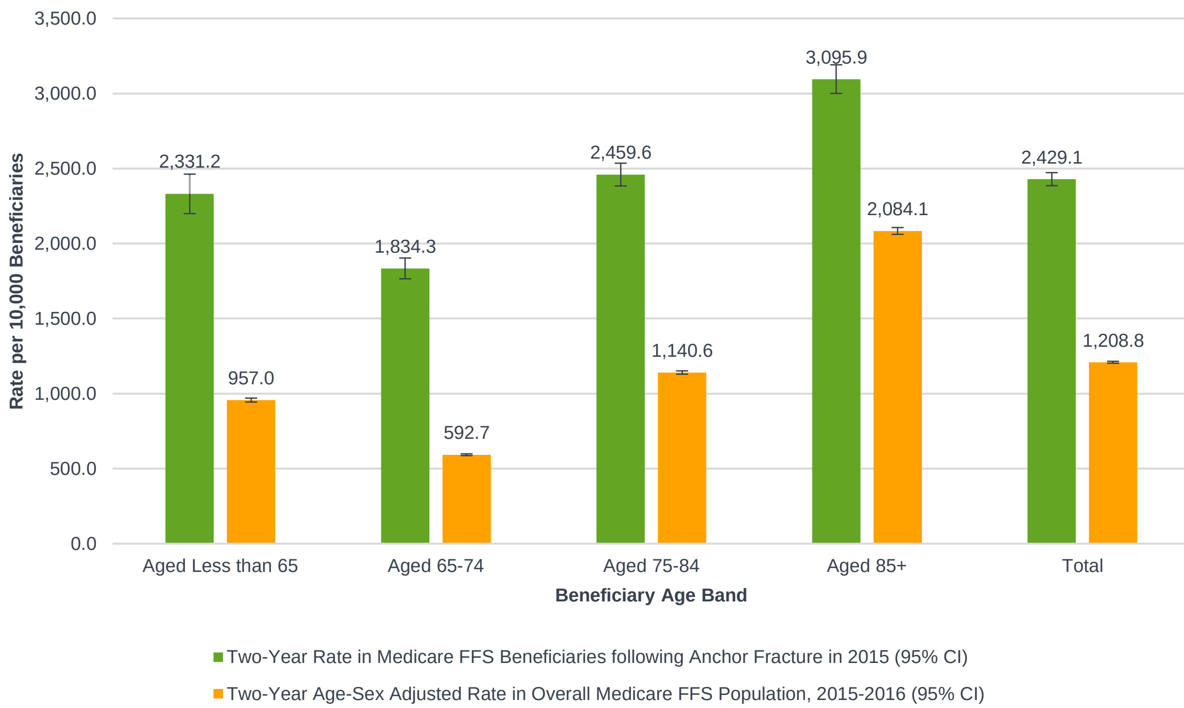
New pressure ulcers

Nearly 20% of Medicare FFS beneficiaries had at least one new pressure ulcer during their osteoporotic fracture episodes (Figure 3 above). This is significant because research has found that pressure ulcers are clinically difficult and expensive to manage.[79]

Beneficiaries who had a new osteoporotic fracture had twice the rate of new pressure ulcers as the total Medicare FFS population, after adjusting for age and sex. Figure 6 displays the rate of new pressure ulcers over a two-year period for beneficiaries who had new osteoporotic fractures in 2015 compared to all Medicare FFS beneficiaries, adjusted for age and sex differences.

Specifically, beneficiaries aged 65 to 74 who experienced a new osteoporotic fracture had over three times the pressure ulcer rate as a typical Medicare FFS beneficiary, after adjusting for differences in sex. Additional detail on the two-year rates of new pressure ulcers by fracture type is provided in Appendix D.

FIGURE 6: RATE OF NEW PRESSURE ULCERS PER 10,000 MEDICARE FFS BENEFICIARIES WITH A NEW OSTEOPOROTIC FRACTURE COMPARED TO TOTAL FFS POPULATION, BY BENEFICIARY AGE BAND



Note: Beneficiaries who died within the two-year time period were not excluded from the denominator of the percentages (i.e., beneficiaries were not required to survive for two years following their initial osteoporotic fracture). Confidence intervals for the two-year rates were approximated using the standard error of an age- and sex-adjusted rate, assuming the rate to be a binomial proportion.

Becoming eligible for Medicaid benefits or institutionalized

The table in Figure 7 provides the percentage of Medicare beneficiaries with a new osteoporotic fracture who became eligible for Medicaid benefits or became institutionalized in a nursing facility following their new osteoporotic fracture. Medicare beneficiaries who become eligible for Medicaid benefits in addition to Medicare benefits are said to be “dual eligibles.” Medicaid fills in the gaps in Medicare’s benefit package for these individuals by providing financial assistance for Medicare’s premiums and cost sharing.[80] Dual eligible beneficiaries incur cost to both Medicare and Medicaid. Although dual eligibles accounted for only 15% of Medicaid enrollment in 2012, 33% of all Medicaid expenditures were made on their behalf.[81] Similarly, dual eligibles made up 20% of the Medicare population but accounted for 34% of Medicare spending in 2012.[81] Over the course of an episode of care that lasted up to two to three years, over 7% of Medicare FFS beneficiaries with a new osteoporotic fracture became eligible for Medicaid.

Similarly, almost 4% of Medicare FFS beneficiaries with a new osteoporotic fracture became institutionalized, which means they required the custodial care provided in a nursing home. Institutionalization may lead to dual eligible status if beneficiaries spend their assets for custodial care to the point where they meet the poverty criteria for Medicaid. The personal cost of institutional care to patients is high; Genworth reported that the median annual cost for a private room in a nursing home was over $100,000 in 2018 and has increased by 3.16% annually since 2004.[82] Similarly, public spending on long-term care is substantial, with the Kaiser Family Foundation reporting that Medicaid spending for nursing facility long-term care totaled over $43.3 billion in 2017.[83]

The two categories (i.e., institutionalized beneficiaries and dual eligibles) are not mutually exclusive.

FIGURE 7: PERCENTAGE OF MEDICARE FFS BENEFICIARIES WITH A NEW OSTEOPOROTIC FRACTURE IN WHICH THE BENEFICIARY BECAME DUAL ELIGIBLE OR INSTITUTIONALIZED DURING THE OSTEOPOROTIC FRACTURE EPISODE, BY TIME AFTER FRACTURE EVENT

TIME AFTER FRACTURE EVENT	BENEFICIARY BECAME DUAL ELIGIBLE	BENEFICIARY BECAME INSTITUTIONALIZED
1-6 Months After Fracture Event	3%	1%
6-12 Months After Fracture Event	3%	1%
12-18 Months After Fracture Event	1%	1%
More than 18 Months After Fracture Event	2%	0%
Total During Episode	**7%**	**4%**

Note: Totals may not add to the sum of each time period because percentages have been adjusted for beneficiary mortality prior to the beginning of the event period. Beneficiaries who died prior to the start of the event period were excluded from the denominator of the percentage.

Death

Figure 3 above shows that 32% of beneficiaries died within two to three years of a new osteoporotic fracture. The average annual age-band mortality rate for Medicare FFS beneficiaries aged 65 and older following a fracture was over three times greater than the average age- and sex-adjusted mortality rate for individuals aged 65 and older in 2015 in those age bands (Figure 8).

FIGURE 8: ANNUAL MORTALITY RATES PER 10,000, BY AGE BAND

	AGED 65-74	AGED 75-84	AGED 85+	TOTAL AGED 65+
Mortality Rate of Medicare FFS Beneficiaries With a New Osteoporotic Fracture Within 12 Months of Fracture	1,085.5	1,842.4	3,186.9	1,989.6
Age- and Sex-Adjusted Annual Mortality Rate in the United States, 2015*	168.5	437.0	1,349.2	618.2

* Source: Mortality rates reported by the CDC for 2015,[84] adjusted for differences in age band and sex between total U.S. population and population of Medicare FFS beneficiaries with a new osteoporotic fracture.

The average annual mortality rate for Medicare FFS beneficiaries aged 65 and older following a fracture was over three times greater than the average age- and sex-adjusted mortality rate for individuals aged 65 and older in 2015.

The mortality rate varied by beneficiary age and sex, type of new osteoporotic fracture, and timing of death relative to the fracture. The table in Figure 9 shows the percentage of Medicare FFS beneficiaries who died within six months and 12 months following an osteoporotic fracture. The risk of death was highest in the months immediately following a fracture. Nearly 20% of Medicare beneficiaries died within 12 months following a fracture, compared to only 6% of an age- and sex-adjusted population of individuals over age 65 in the United States.

Based on the total number of Medicare FFS beneficiaries in 2015,[69] we estimated that approximately 250,000 Medicare FFS beneficiaries aged 65 and older died within 12 months after experiencing a new osteoporotic fracture, which accounted for 12% of the 2.0 million total deaths in 2015 among individuals aged 65 and older in the United States reported by the Centers for Disease Control and Prevention (CDC).[84] The 250,000 Medicare deaths of beneficiaries aged 65 and older do not include beneficiaries covered by MA, which accounts for about 30% of the total Medicare population.[69]

We estimate that approximately 260,000 Medicare FFS beneficiaries, including those aged 64 and younger, died within 12 months after a new osteoporotic fracture. Of these, about 164,000 were female and 96,000 were male.

FIGURE 9: PERCENTAGE OF MEDICARE FFS BENEFICIARIES WITH A NEW OSTEOPOROTIC FRACTURE THAT DIED WITHIN SPECIFIED TIME PERIODS FOLLOWING THE FRACTURE EVENT

FRACTURE TYPE	WITHIN 6 MONTHS AFTER FRACTURE EVENT	WITHIN 12 MONTHS AFTER FRACTURE EVENT	ESTIMATED DEATHS WITHIN 12 MONTHS AFTER FRACTURE EVENT IN 2015 (000S)
Hip	23%	30%	76
Distal Femur Shaft/Distal Femur	18%	25%	11
Pelvis/Sacrum	16%	22%	17
Tibia/Fibula	6%	10%	16
Humerus	11%	16%	21
Radius/Ulna	5%	8%	4
Distal Radius/Ulna	4%	8%	9
Clavicle	12%	18%	5
Spine	14%	21%	73
Rib	11%	16%	28
Total	**13%**	**19%**	**260**

Beneficiaries who had a new osteoporotic hip fracture had the highest mortality rate within the 12-month period following the fracture, with over 30% dying in the 12-month period following the fracture. Researchers have previously reported mortality rates up to 21% to 27% in the first year following a hip fracture.[85,86] Our analysis indicated that other fracture types commonly considered to be high-severity fractures, such as spine, also had relatively high mortality rates (21%) within the 12-month period following the fracture.

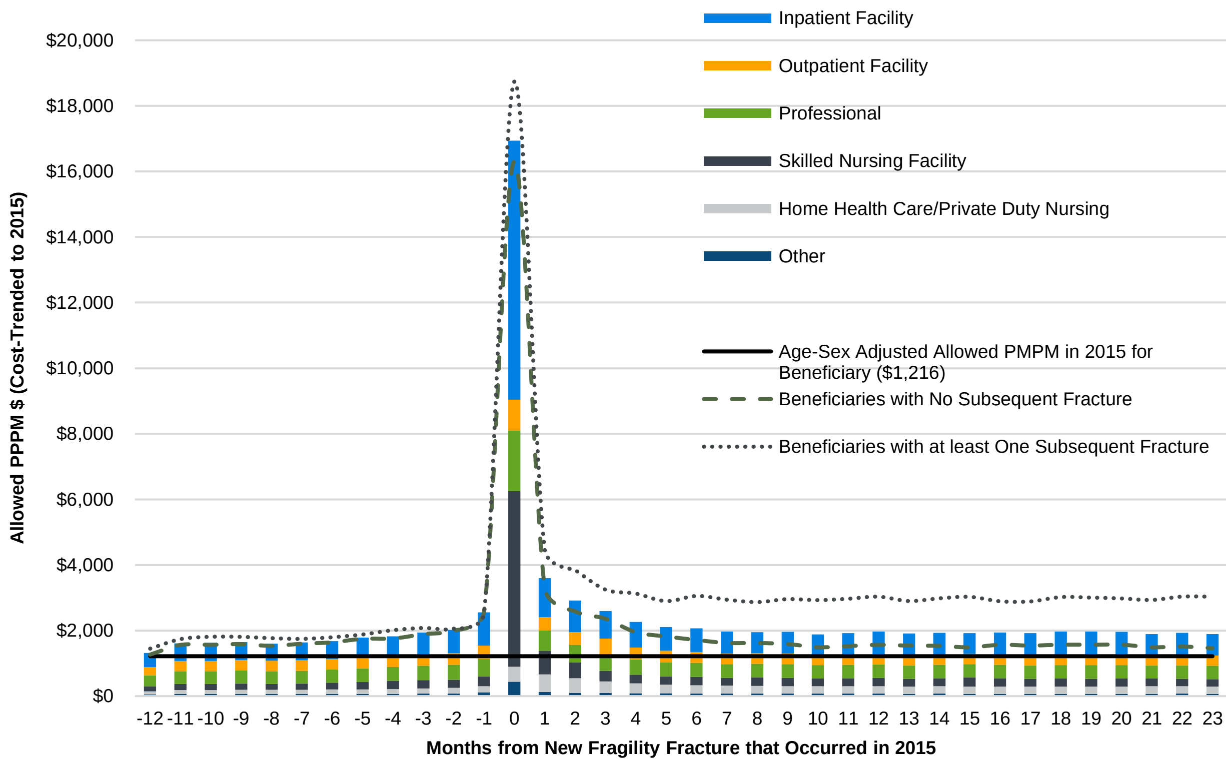
An estimated 260,000 Medicare FFS beneficiaries, or nearly one in five, died within 12 months of a new osteoporotic fracture in 2015. For beneficiaries with a hip fracture, 30% died within 12 months of the fracture.

COST OF FRACTURE CARE

Medical care required after an osteoporotic fracture is expensive. The incremental annual allowed medical cost for osteoporotic fractures (which includes amounts paid by Medicare and beneficiary cost sharing) was $21,844 per beneficiary with a new osteoporotic fracture in 2015.

Figure 10 shows the monthly per patient per month (PPPM) allowed cost of patients across a portion of the study period, including 12 months prior to the new osteoporotic fracture that occurred in 2015, the month of the new osteoporotic fracture (i.e., month 0), and the period following the new osteoporotic fracture. All PPPM costs have been adjusted to 2015 dollars using Medicare FFS cost trends published by the Centers for Medicare and Medicaid Services (CMS). In Figure 10, we have also included the average allowed per member per month (PMPM) cost for the total Medicare FFS population in 2015, adjusted for the age and sex of the beneficiaries with a new osteoporotic fracture ($1,216 PMPM).

FIGURE10: LONGITUDINAL PPPM ALLOWED COST SUMMARY FOR MEDICARE FFS BENEFICIARIES WITH A NEW OSTEOPOROTIC FRACTURE



Note: The bar graph provides the composite medical allowed PPPM cost incurred by month and service category for all Medicare FFS beneficiaries within the LDS identified with a new osteoporotic fracture in 2015 (n = 49,273). The dashed line reflects the average allowed cost by month across all medical services for beneficiaries identified with no subsequent fracture during the osteoporotic fracture episode (n = 36,457). The dotted line reflects the average allowed cost by month across all medical services for beneficiaries identified with at least one subsequent fracture during the osteoporotic fracture episode (n = 12,816). The bolded level line reflects the average age- and sex-adjusted medical allowed PMPM in 2015 across all medical services for the total Medicare FFS population (n = 1,331,643).

In the year prior to the new osteoporotic fracture, beneficiaries that had osteoporotic fractures had similar allowed PPPM medical costs, whether or not they ultimately also had subsequent fractures. However, the average allowed PPPM for fracture beneficiaries in the year prior to the new osteoporotic event ($1,767) was nearly 50% higher than the 2015 average allowed PMPM for the average Medicare FFS beneficiary ($1,216), after adjusting for differences in sex and age and trending to 2015 using Medicare cost trends. Differences in comorbidities likely contributed to these findings.

Average allowed costs remained elevated after the osteoporotic fracture compared to allowed costs from the year prior to the fracture. The average per-patient allowed cost was over $2,000 per month between months 3 and 11 ($2,083 per month), nearly 20% greater than the average monthly allowed cost in the year prior to the new osteoporotic fracture event ($1,767 per month), after adjusting for cost trend.

Average allowed costs in the second year following the new osteoporotic fracture for beneficiaries who had no subsequent fracture decreased to a level below the average cost for the same beneficiaries in the year prior to the new osteoporotic event, likely due to survivorship bias, which means the survivors to this period were likely healthier and lower-cost than the patients who died before this period. For high-risk fracture types, there was high mortality immediately following the new osteoporotic fracture (Figure 9 above). Patients who died shortly after the new osteoporotic fracture were more likely to be higher-cost, with complicated comorbidities (based on their cost experience in the year prior to the new osteoporotic fracture), which left a group of lower-cost patients in the later months.

The table in Figure 11 presents the difference and the average ratio of annual costs incurred between the year following the beneficiary's new osteoporotic fracture (which includes the new osteoporotic fracture itself) and the year prior to the new osteoporotic fracture, illustrating the increase in costs for the year following a fracture. These relativities also include adjustments for Medicare FFS cost trend, but do not account for the impact of aging on the cohort of Medicare FFS beneficiaries with a new osteoporotic fracture in 2015, which we would expect to reduce the relativities by an absolute 2% to 4%.

FIGURE 11: ESTIMATED INCREMENTAL ANNUAL ALLOWED MEDICAL COST INCURRED BETWEEN THE YEAR FOLLOWING A NEW OSTEOPOROTIC FRACTURE (INCLUDING THE NEW OSTEOPOROTIC EVENT) AND THE YEAR PRIOR TO THE NEW OSTEOPOROTIC FRACTURE, BY TYPE OF FRACTURE AND PRESENCE OF A SUBSEQUENT FRACTURE

FRACTURE TYPE	ALL BENEFICIARIES WITH A NEW OSTEOPOROTIC FRACTURE	BENEFICIARIES WITH NO SUBSEQUENT FRACTURE DURING OSTEOPOROTIC FRACTURE EPISODE	BENEFICIARIES WITH AT LEAST ONE SUBSEQUENT FRACTURE DURING OSTEOPOROTIC FRACTURE EPISODE
Hip	$47,237 (205%)	$42,065 (183%)	$60,499 (260%)
Distal Femur Shaft/Distal Femur	$27,318 (81%)	$21,526 (64%)	$42,461 (128%)
Pelvis/Sacrum	$22,980 (93%)	$18,131 (76%)	$32,992 (122%)
Tibia/Fibula	$16,798 (87%)	$14,314 (78%)	$28,051 (116%)
Humerus	$19,994 (105%)	$16,697 (89%)	$29,640 (146%)
Radius/Ulna	$8,474 (54%)	$5,745 (41%)	$16,680 (83%)
Distal Radius/Ulna	$9,630 (67%)	$6,698 (50%)	$18,696 (105%)
Clavicle	$11,397 (55%)	$8,420 (44%)	$19,733 (79%)
Spine	$18,418 (80%)	$15,855 (68%)	$24,255 (108%)
Rib	$12,887 (62%)	$9,583 (47%)	$23,791 (105%)
Total	**$21,844 (102%)**	**$18,173 (87%)**	**$32,029 (141%)**

Note: Beneficiaries who died within the year following their new osteoporotic fractures were included in these incremental annual medical cost estimates. To adjust for the impact of mortality, these estimates assign a weight to each member based on the count of months during which they were alive during the period. The result is an average monthly cost estimate, which was annualized by multiplying by 12.

Average allowed costs in the year following the new osteoporotic fracture were significantly higher than in the year prior to the new osteoporotic fracture for all beneficiaries, regardless of fracture type and whether a subsequent fracture occurred. For hip fractures, average costs in the year following the fracture (including the cost of the hip fracture) were over 200% greater than costs in the year prior to the new osteoporotic fracture, which was more than double the average cost differential for all fracture types (Figure 11, top row, left).

Beneficiaries with no subsequent fracture during their osteoporotic fracture episode had costs that were 87% higher in the year following the new osteoporotic fracture than costs in the year prior (Figure 11, bottom row, middle). For beneficiaries with at least one subsequent fracture, this cost differential was even greater; costs were 141% higher in the year immediately following the new osteoporotic fracture than in the year prior to the new osteoporotic fracture (Figure 11, bottom row, right).

The table in Figure 12 presents the difference and the average ratio of annual costs incurred between the year following the beneficiary's new osteoporotic fracture (which includes the new osteoporotic fracture itself) and the year prior to the new osteoporotic fracture by service type, illustrating the source of the increase in costs for the year following a fracture. Similar to Figure 11, these relativities also include adjustments for Medicare FFS cost trend, but do not account for the impact of aging on the cohort of Medicare FFS beneficiaries with a new osteoporotic fracture in 2015, which we would expect to reduce the relativities by an absolute 2% to 4%.

FIGURE 12: ESTIMATED INCREMENTAL ANNUAL ALLOWED MEDICAL COST INCURRED BETWEEN THE YEAR FOLLOWING A NEW OSTEOPOROTIC FRACTURE (INCLUDING THE NEW OSTEOPOROTIC EVENT) AND THE YEAR PRIOR TO THE NEW OSTEOPOROTIC FRACTURE, BY SERVICE CATEGORY AND PRESENCE OF A SUBSEQUENT FRACTURE

SERVICE CATEGORY	ALL BENEFICIARIES WITH A NEW OSTEOPOROTIC FRACTURE (N=49,273)	BENEFICIARIES WITH NO SUBSEQUENT FRACTURE DURING OSTEOPOROTIC FRACTURE EPISODE (N=36,457)	BENEFICIARIES WITH AT LEAST ONE SUBSEQUENT FRACTURE DURING OSTEOPOROTIC FRACTURE EPISODE (N=12,816)
Inpatient Facility	$9,538 (131%)	$8,337 (118%)	$12,868 (161%)
Outpatient Facility	$932 (23%)	$668 (17%)	$1,665 (41%)
Professional	$2,051 (41%)	$1,613 (33%)	$3,263 (62%)
Skilled Nursing Facility	$6,643 (256%)	$5,243 (210%)	$10,534 (371%)
Home Health and Private Duty Nursing	$2,111 (128%)	$1,867 (115%)	$2,788 (164%)
Other	$569 (66%)	$445 (52%)	$912 (104%)
Total Estimated Annual Medical Cost	**$21,844 (102%)**	**$18,173 (87%)**	**$32,029 (141%)**

Note: Beneficiaries who died within the year following a new osteoporotic fracture were included in these incremental annual medical cost estimates. To adjust for the impact of mortality, these estimates assign a weight to each member based on the count of months for which they were alive during the period. The result is an average monthly cost estimate, which was annualized by multiplying by 12.

Our analysis indicated that the additional cost in the year following the new osteoporotic fracture was predominantly attributed to increases in costs for inpatient services, including skilled nursing facilities (SNFs). Across all beneficiaries who had an osteoporotic fracture, the cost of non-SNF inpatient facility services increased by 131%, or over $9,500, between the year prior to the new osteoporotic fracture and the year immediately following the new osteoporotic fracture (after adjusting for Medicare FFS cost trend). The cost differential for non-SNF inpatient services varied between 118% for beneficiaries with no subsequent fracture during the follow-up period and 161% for beneficiaries with at least one subsequent fracture during the follow-up period.

The cost of SNF services increased greatly after Medicare FFS beneficiaries had an osteoporotic fracture. On average across all beneficiaries who had an osteoporotic fracture in 2015, the cost of SNF services increased by 256%, or over $6,600, between the year prior to and the year immediately following the new osteoporotic fracture, after adjusting for Medicare FFS cost trend, with the average length of stay for SNF admissions increasing by 8% in the same period.

COST OF A SUBSEQUENT FRACTURE

As described above, among Medicare FFS beneficiaries with a new osteoporotic fracture in 2015, individuals who experienced a subsequent fracture had higher medical costs than those who did not. In order to quantify potential savings that could be achieved if subsequent fractures could be prevented, such as through increased rates of BMD testing and treatment, we used Medicare claims data to estimate the incremental cost to Medicare FFS of subsequent fractures. We limited our estimate to those additional costs incurred to Medicare within a 180-day period of the subsequent osteoporotic fracture.

Based on the actual average allowed medical costs of the beneficiaries with a subsequent fracture, we estimated that the unadjusted average incremental medical cost of a subsequent fracture in the 180-day period following the subsequent fracture was over $19,200.

After adjusting for differences in risk characteristics between the populations of Medicare FFS beneficiaries with a new osteoporotic fracture who had a subsequent fracture and those who did not, we estimated the adjusted incremental medical cost of the subsequent fracture to be over $20,700 (95% CI: $19,900 to $21,800). An estimated 307,000 Medicare FFS beneficiaries suffered a subsequent fracture during a follow-up period of up to two to three years and survived at least 180 days following the subsequent fracture, which would account for over $6.3 billion in allowed cost to Medicare FFS (95% CI: $6.1 billion to $6.7 billion). This estimate of incremental cost was adjusted for differences in the following risk characteristics:

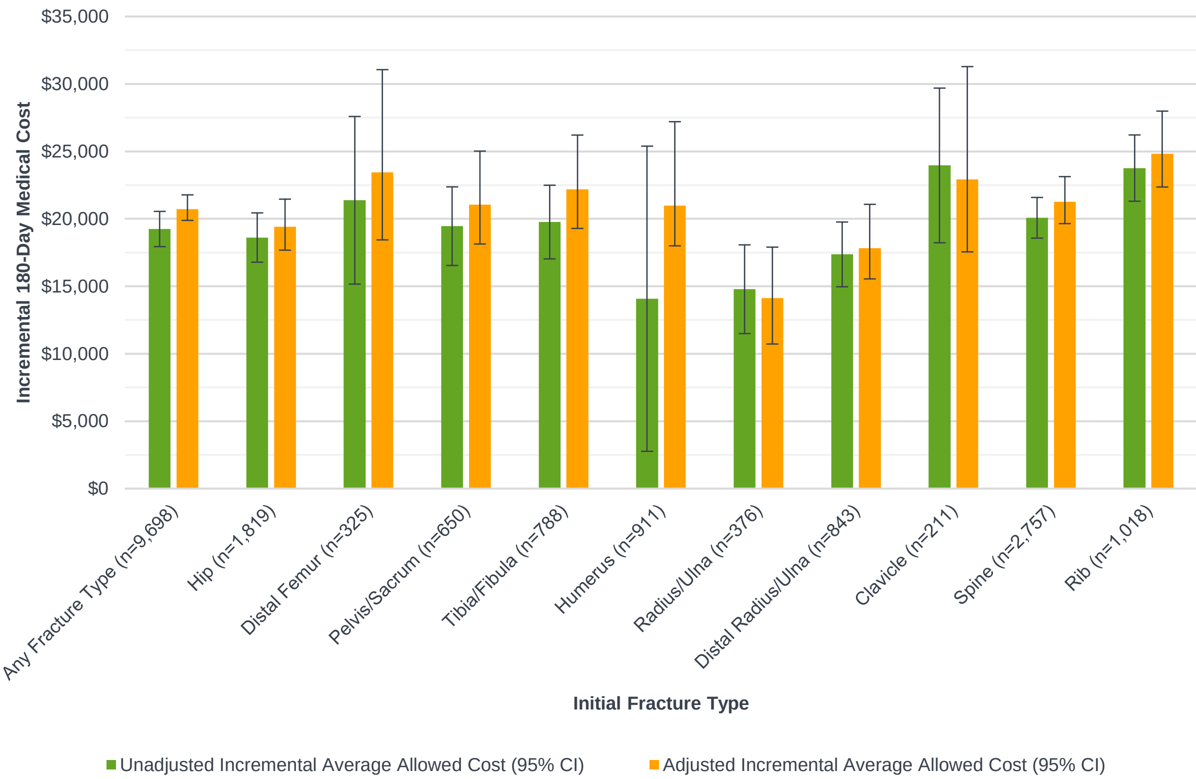
- New osteoporotic fracture type
- Age band
- Sex
- Geographic region of residence
- Beneficiary type (i.e., beneficiaries with metastatic cancer or bone cancer, beneficiaries with nonmetastatic or non-bone cancer, beneficiaries with ESRD, or all other beneficiaries)
- Dual eligibility status as of January 2015
- Institutionalized status as of January 2015
- Presence of an osteoporosis diagnosis between 2014 and 2017
- Count of CMS Hierarchical Condition Categories (CMS-HCCs) in 2014

Note that these estimates of the incremental cost of a subsequent fracture include only medical expenditures, as Part D pharmacy claims were not available.

> The estimated risk-adjusted incremental medical cost of a subsequent fracture over the six-month period following the fracture is over $20,700, which would account for over $6.3 billion in allowed cost to Medicare FFS for the estimated 307,000 Medicare FFS beneficiaries with a subsequent fracture during a follow-up period of up to two to three years and who survived at least 180 days following their subsequent fracture.

The results from our analyses on the estimated incremental 180-day medical cost of a subsequent fracture by new osteoporotic fracture type are shown in Figure 13.

FIGURE 13: ESTIMATED INCREMENTAL 180-DAY MEDICAL COST OF SUBSEQUENT FRACTURE AMONG MEDICARE FFS BENEFICIARIES WITH A NEW OSTEOPOROTIC FRACTURE, BY TYPE OF INITIAL FRACTURE



Note: Confidence intervals for the unadjusted incremental average allowed cost were calculated using the standard error of the sampling distribution of difference between means. Confidence intervals for the adjusted incremental average allowed cost were calculated using bootstrapping (see Appendix D for additional details).

Our findings on the incremental cost of a subsequent fracture are similar to those of Weaver et al., who estimated that the average healthcare cost, including pharmacy expenditures, in the year following a new osteoporotic fracture for patients who have a subsequent fracture was over $14,000 greater than the total healthcare cost for patients without a subsequent fracture.[87]

COST SAVINGS FROM PREVENTING SUBSEQUENT FRACTURES

Using results from our claims-based data analyses, as well as a range of assumptions informed by our review of the literature on secondary fracture prevention models of care, we modeled the potential savings in the United States from preventing a portion of subsequent fractures in a national Medicare FFS population. The table in Figure 14 provides a summary of the estimated national savings under three scenarios, which use different assumptions for the percentage of subsequent fractures that are prevented.

FIGURE 14: ESTIMATED NATIONWIDE SAVINGS FROM PREVENTING SUBSEQUENT FRACTURES AMONG MEDICARE FFS BENEFICIARIES WHO HAD A NEW OSTEOPOROTIC FRACTURE IN 2015, UNDER THREE SCENARIOS

	5% SUBSEQUENT FRACTURES AVOIDED	10% SUBSEQUENT FRACTURES AVOIDED	20% SUBSEQUENT FRACTURES AVOIDED
Estimated national annual Medicare FFS beneficiaries with a new osteoporotic fracture in 2015	1,371,000	1,371,000	1,371,000
Estimated national new osteoporotic fracture cases with a subsequent fracture where the patient survives 180 days after the subsequent fracture	305,300	305,300	305,300
Assumed percentage of subsequent fractures that are prevented	5%	10%	20%
Estimated prevented subsequent fractures in a national Medicare FFS population	15,290	30,530	61,060
Direct per-fracture incremental 180-day medical cost of preventable subsequent fractures	$20,988	$20,986	$20,988
Estimated gross savings from prevented subsequent fractures in a motional Medicare FFS population ($ millions)	**$320.9**	**$640.7**	**$1,281.5**
Assumed percentage of additional new osteoporotic fracture cases with a subsequent BMD test	10%	30%	50%
Estimated incremental cost of providing additional BMD tests following new osteoporotic fractures ($ millions)	$10.4	$30.9	$51.4
Estimated net post-testing savings from prevented subsequent fractures in a national Medicare FFS population ($ millions) (95% CI)	**$310.5** **($271.9 to $358.3)**	**$609.8** **($532.4 to $705.2)**	**$1,230.1** **($1,075.7 to $1,420.9)**

Note: Estimated prevented subsequent fractures and the resulting estimates of savings were calculated by fracture type and rounded. The results in this table reflect the sum of the rounded estimates across the 10 fracture types and thus may not equal the direct calculations. Confidence intervals for the estimated net savings reflect only variation in the per-fracture cost and were calculated by varying the direct per-fracture incremental 180-day medical cost of preventable subsequent fractures between the lower bound and upper bound of the 95% confidence intervals by fracture type shown in Figure 13 above.

Preventing between 5% and 20% of subsequent fractures, coupled with performing BMD tests on an additional 10% to 50% of patients with new osteoporotic fractures, could have saved between $310 million (95% CI: $272 million to $358 million) and $1,230 million (95% CI: $1,076 million to $1,421 million) for the Medicare FFS program during a new osteoporotic fracture follow-up period of up to two to three years, based on the historical incidence and treatment patterns of beneficiaries who had an osteoporotic fracture in 2015. Medicare FFS payments for Part A and Part B benefits totaled approximately $377 billion in 2015.[88] We note that this savings estimate does not account for any increased costs of osteoporosis treatment beyond additional BMD tests or additional administrative costs of the secondary fracture prevention program.

An osteoporotic fracture is a sentinel event that should trigger appropriate clinical attention directed to reducing the risk of future subsequent fractures. Implementation of a secondary fracture prevention initiative, such as an FLS, which seeks to identify those at high risk for subsequent fracture and to improve treatment rates and adherence through better care coordination, may reduce the incidence of subsequent fractures and, therefore, reduce costs due to such fractures. Our modeled cost savings from preventing a percentage of subsequent fractures in Medicare FFS beneficiaries who experience an osteoporotic fracture has the potential to be realized through widespread implementation of FLS programs that achieve these rates of subsequent fracture prevention, before considering the costs of additional osteoporosis treatment and operation of the FLS programs.

While savings may be achievable with a reduction in subsequent fractures, there are several limitations to this analysis:

- This analysis was performed for the Medicare FFS population. Resulting estimates of the potential cost savings did not include savings derived from preventing subsequent fractures among beneficiaries covered by MA, which accounts for an additional 16 million individuals, or about 30% of the total Medicare population.[69]

- Our estimates of the savings do not account for the cost of providing additional services beyond BMD tests, such as pharmaceutical therapies, care coordination and referral, or other osteoporosis treatment.
- Our estimates of the per-fracture incremental cost of preventable subsequent fractures include only the direct medical costs associated with subsequent fractures and do not consider the cost of pharmaceutical treatment or any indirect costs, which may include loss of productivity and absenteeism.[89]
- Our estimates of the incremental 180-day cost of preventable subsequent fractures required that beneficiaries survived at least 180 days following the subsequent fracture. The impact of reducing subsequent fractures on mortality and end-of-life costs was not considered.
- Our estimates assumed that any reduction in subsequent fractures would be applied proportionally across the entire Medicare FFS population and all fracture types.
- The assumptions about preventable subsequent fractures (5%, 10%, and 20%) were based on our review of the relevant literature surrounding the efficacy of programs in preventing subsequent fractures after a new osteoporotic fracture. As discussed in the Background section of this report, there is a high degree of variability and uncertainty in these assumptions.

DISCUSSION

The table in Figure 15 summarizes key findings from our analysis of osteoporotic fractures suffered by Medicare FFS beneficiaries.

FIGURE 15: SUMMARY OF KEY FINDINGS

	VALUE
Estimated count of Medicare FFS beneficiaries who suffered an osteoporotic fracture in 2015	1.4 million
Percentage of Medicare FFS beneficiaries with a new osteoporotic fracture in 2015 who were hospitalized within one week after the fracture	40%
Percentage of female Medicare FFS beneficiaries who were evaluated for osteoporosis with a BMD test within six months after a new osteoporotic fracture in 2015	9%
Estimated count of Medicare FFS beneficiaries who suffered one or more subsequent fractures within 12 months of an initial osteoporotic fracture in 2015	205,000
Estimated count of Medicare FFS beneficiaries who died within 12 months after a new osteoporotic fracture in 2015	260,000
Estimated incremental medical 180-day cost of a subsequent fracture following a new osteoporotic fracture suffered by a Medicare FFS beneficiary in 2015	$20,700
Estimated total incremental medical 180-day cost of all subsequent fractures following new osteoporotic fractures during a follow-up period of up to two to three years following a new osteoporotic fracture in 2015 for Medicare FFS beneficiaries who survived for at least 180 days after the subsequent fracture	$6.3 billion
Potential direct medical cost savings from preventing between 5% and 20% of subsequent fractures during a follow-up period of up to two to three years after a new osteoporotic fracture, net of the cost of performing BMD tests on an additional 10% to 50% of new osteoporotic fracture patients	$310 million to $1,230 million

Our analysis of Medicare FFS claims data found that the clinical burden of fracture on Medicare FFS beneficiaries is significant, with individuals experiencing high rates of subsequent fracture and death following an osteoporotic fracture. Other studies suggest that osteoporosis is underdiagnosed due to low screening rates[20,90,91] and undertreated following an osteoporotic fracture.[92] Consistent with these reports, we found that only 9% of female Medicare FFS beneficiaries received BMD testing within six months after a new osteoporotic fracture. Average MA rates of testing and treatment for women within six months post-fracture, which include both BMD testing and pharmaceutical therapies, are approximately 45% for 2017.[41]

Osteoporotic fractures were also a significant cost to Medicare, with 1.4 million beneficiaries having incurred an additional $21,800 in the year following a new osteoporotic fracture in 2015 as compared to the year before the fracture, after adjusting for cost trend.

This difference was even larger, at over $32,000 in the year following a new osteoporotic fracture compared to the year before the fracture, for those beneficiaries who also experienced a subsequent fracture in the first year after their initial osteoporotic fractures.

An osteoporotic fracture is a sentinel event that indicates a high risk for subsequent fractures. We found that the one-year age- and sex-adjusted rate of subsequent fractures among beneficiaries who had a new osteoporotic fracture was over three times the one-year rate of new osteoporotic fractures among Medicare FFS beneficiaries in 2015. Therefore, the months following an osteoporotic fracture, in which the risk of a subsequent fracture is high, provide an important opportunity to identify and treat osteoporosis and to perform other interventions, such as patient education and care coordination, in order to reduce the individual's risk of a subsequent fracture.

Preventing a subsequent fracture avoids the clinical and financial burden of the event for the patient and payer. Our analysis indicated that preventing a subsequent fracture would be expected to lead to an estimated per-fracture savings to Medicare FFS of over $20,700 (95% CI: $19,900 to $21,800) in the six-month period following the subsequent fracture. We modeled the cost impact of enhanced secondary fracture prevention that resulted in small to modest reductions in the percentage of subsequent fractures. We estimated net post-BMD testing savings between

$310 million (95% CI: $272 million to $358 million) and $1,230 million (95% CI: $1,076 million to $1,421 million) for the Medicare program from Medicare FFS beneficiaries with a new osteoporotic fracture in 2015 within a follow-up period that lasted up to two to three years.

There was minimal impact from the adjustment for risk characteristics in our analysis of the cost of a subsequent fracture among osteoporotic fracture patients who had subsequent fractures, suggesting that those patients had overall demographic and health risk characteristics similar to patients who did not experience subsequent fractures. Whether predictive modeling can identify those at highest risk of subsequent fracture remains unknown and further research is needed.

Secondary fracture prevention programs have been implemented in the United States and multiple other countries. They share defining characteristics, such as appropriate targeting of osteoporosis patients for long-term follow-up care that includes subsequent BMD testing and pharmaceutical therapies. Despite their programmatic heterogeneity, such programs generally aim to improve guideline-based post-fracture care, including increasing the rate of BMD testing and treatment initiation and adherence, which may lead to a reduction in the risk of subsequent fractures. However, results from such programs are inconsistent, with published research suggesting reductions in refracture incidence associated with FLS programs ranging from 0% over a 10-year period[65] to 80% over a four-year period.[62]

Further research would help more clearly identify the characteristics of successful secondary fracture prevention initiatives, and to measure the changes in cost associated with the avoidance of subsequent fractures based on real-world interventions. In future analysis, it will be important to net the total cost of the intervention and additional pharmaceutical treatment for osteoporosis against Medicare savings from avoided subsequent fractures to comprehensively measure the savings from secondary fracture prevention initiatives.

APPENDIX A: DATA SOURCES

KEY DATA SOURCES

Medicare 5% sample

This Limited Data Set (LDS) contains all Medicare FFS paid claims generated by a statistically balanced sample of Medicare FFS beneficiaries. Information includes diagnosis codes, procedure codes, and diagnosis-related group (DRG) codes, along with site of service information, beneficiary age, eligibility status, and an indicator for HMO enrollment. The data are released on an annual basis. We used Medicare 5% beneficiary sample data for 2014-2017.

Milliman's 65+ Health Cost Guidelines™ (HCGs)

The HCGs provide a flexible but consistent basis for the determination of health claims costs and premium rates for a wide variety of health plans. The HCGs are developed as a result of Milliman's continuing research on healthcare costs. First developed in 1954, the HCGs have been updated and expanded annually since that time. The HCGs are continually monitored as they are used in measuring the experience or evaluating the rates of health plans, and as they are compared to other data sources. The HCGs were developed to be representative of the age and sex distribution for the Medicare FFS population. The standard demographics were developed using data from the Medicare 5% sample and publicly available Medicare demographic population data.

OTHER DATA SOURCES

In developing estimates of the incremental cost of a subsequent fracture with regression methods, the Medicare allowed cost amounts were normalized to 2015 for trend. This adjustment is based on the medical care component of the Consumer Price Index (CPI), available from the U.S. Bureau of Labor Statistics (BLS).[93]

APPENDIX B: METHODOLOGY

DENOMINATOR POPULATION

The denominator population for the Medicare FFS beneficiaries identified with a new osteoporotic fracture in 2015 was defined as beneficiaries in the Medicare 5% LDS who met the following criteria:

- Enrolled in Medicare FFS with continuous Part A and Part B coverage in a non-capitated benefit plan from January 1, 2014, through December 31, 2017, or until death if the beneficiary died prior to December 31, 2017.

Qualified claims were identified throughout the analysis using the Current Procedural Terminology (CPT)/Healthcare Common Procedure Coding System (HCPCS) codes and revenue codes found in Appendix C.

Beneficiaries in the following four separate cohorts were included in the denominator population. Beneficiaries classified in more than one cohort were assigned to a single cohort using the following hierarchy:

1. <u>Beneficiaries with end-stage renal disease (ESRD)</u>. Beneficiaries with ESRD were identified as beneficiaries who were eligible for Medicare on the basis of ESRD during any month between January 1, 2014, and December 31, 2017.
2. <u>Beneficiaries with metastatic cancer or bone cancer</u>. Beneficiaries with cancer that is metastatic or involving bone were identified by a specified International Classification of Diseases, Ninth Revision (ICD-9-CM) or International Classification of Diseases, Tenth Revision (ICD-10-CM) diagnosis code for metastatic or bone cancer (see Appendix C for specific codes) in any position on at least one qualified claim between January 1, 2014, and December 31, 2017.
3. <u>Beneficiaries with nonmetastatic or non-bone cancer</u>. Beneficiaries with cancer that is not metastatic or involving bone were identified with an ICD-9-CM or ICD-10-CM diagnosis code for nonmetastatic or non-bone cancer (see Appendix C for specific codes) in any position on at least one qualified claim between January 1, 2014, and December 31, 2017.
4. <u>All other beneficiaries (i.e., non-cancer, non-ESRD beneficiaries)</u>. Beneficiaries who were not classified in any of the other three cohorts were included in this cohort.

The denominator population was used as a point of comparison to the population of beneficiaries with a new osteoporotic fracture throughout this study. We have not adjusted these comparisons to the unaffected population of Medicare FFS beneficiaries who did not sustain an osteoporotic fracture.

IDENTIFICATION OF BENEFICIARIES WITH NEW OSTEOPOROTIC FRACTURES

Beneficiaries in the denominator population, as described above, were identified with a new osteoporotic fracture that initiated fracture episodes that extend a minimum two years post-fracture through the following approach:

1. <u>Identify bone fractures</u>. We identified all bone fracture claims for beneficiaries in the denominator population with dates of services in 2015. A bone fracture claim was identified by a specified ICD-9-CM or ICD-10-CM diagnosis code in any position on a qualified claim (see Appendix C for specific codes). Qualified bone fracture claims for beneficiaries were grouped into fractures of the following 10 body regions (i.e., fracture types) using ICD-9-CM and ICD-10-CM diagnoses codes specific to the type of fracture (see Appendix C for specific codes). These regions are generally considered vulnerable to osteoporosis-related bone fractures because they are prone to breaks on low-impact falls.
    a. Pelvis/sacrum (closed)
    b. Hip (closed or pathologic)
    c. Distal femur shaft/distal femur (closed or pathologic)

d. Tibia/fibula, including ankle (closed or pathologic)

e. Humerus (closed or pathologic)

f. Radius/ulna (forearm) (closed)

g. Distal radius/ulna (wrist) (closed, open, or pathologic)

h. Rib

i. Clavicle

j. Spine (closed or pathologic)

For hip fractures identified by qualified outpatient claims, we required at least two qualified claims on separate dates of service within 14 days of each other to identify a hip fracture. For all other types of fracture, including hip fractures identified by non-outpatient qualified claims (i.e., non-acute inpatient, acute inpatient, emergency department, or observation), we required only one qualified claim to identify a fracture.

2. Identify new bone fracture. From the bone fracture claims, we identified new bone fractures for each beneficiary using a clean lookback period with no qualified claims for dates of service for the same beneficiary with a diagnosis code in any position for the same fracture type. For bone fractures identified by ICD-10-CM initial encounter diagnoses codes (i.e., all fractures on or after October 1, 2015, in which the diagnosis code specifies initial encounter) where we were confident that these fractures were new, a six-month lookback period was used. For bone fractures identified by ICD-9-CM diagnosis codes with service dates prior to October 1, 2015, a 12-month lookback period was used to ensure that these fractures were new. The lookback period may have extended to 2014.

   Beneficiaries may have multiple new bone fractures in 2015, including more than one bone fracture of the same type, as long as each fracture was preceded by a clean lookback period. For fractures in which more than one type of bone fracture has the same service date, the following hierarchy was applied to assign a single new bone fracture and fracture type to that service date:

HIERARCHY RANK	FRACTURE TYPE
1	Hip (closed or pathologic)
2	Distal femur shaft/distal femur (closed or pathologic)
3	Pelvis/sacrum (closed)
4	Tibia/fibula, including ankle (closed or pathologic)
5	Humerus (closed or pathologic)
6	Radius/ulna (forearm) (closed)
7	Distal radius/ulna (wrist) (closed, open, or pathologic)
8	Clavicle
9	Spine (closed or pathologic)
10	Rib

3. Identify osteoporotic fractures. From the new bone fractures, we identified osteoporotic fractures, which are those new bone fractures that are not associated with a high-impact event. High-impact events are likely caused by accidents or other traumatic events, so they are not considered osteoporosis-related bone fractures. A high-impact fracture was identified by the occurrence of a qualified claim within seven days of the date of the new fracture (i.e., spanning the period of seven days prior to the fracture index date through seven days following the fracture index date, including the index date itself), with an ICD-9-CM or ICD-10-CM diagnosis code representing a high impact event (see Appendix C for specific codes).

4. Identify new osteoporotic fractures. A beneficiary's new osteoporotic fracture was defined as that beneficiary's osteoporotic fracture with the earliest date of service in 2015, which initiates the beneficiary's

"osteoporotic fracture episode." Additional osteoporotic fractures for the same beneficiary later in 2015 did not initiate new osteoporotic fracture episodes; they were referred to subsequent fractures.

Beneficiaries who initiated osteoporotic fracture episodes comprised the study population. Due to the underreporting of osteoporosis diagnoses,[90] we did not attempt to identify new osteoporotic fractures among beneficiaries who had a diagnosis of osteoporosis as this would not meaningfully reflect the full group of beneficiaries with osteoporosis-related fractures.

IDENTIFICATION OF KEY DIAGNOSES AND EVENTS DURING FRACTURE EPISODES

Key events during fracture episodes were identified for beneficiaries in the study population:

1. Other major conditions. We identified beneficiaries with osteoporosis by the presence of an ICD-9-CM or ICD-10-CM diagnosis code for osteoporosis (see Appendix C for specific codes) in any diagnosis code position on a qualified claim for a service provided between January 1, 2014, and December 31, 2017. Other chronic condition comorbidities of members of the study population were identified using CMS Hierarchical Condition Categories (CMS-HCCs) based on diagnoses for claims with service dates in 2014 (see Appendix C for specific codes). See Appendix D for further information on the prevalence and distribution of HCCs among beneficiaries who had a new osteoporotic fracture.
2. Acute inpatient hospitalizations. Hospitalizations were identified as a qualifying inpatient stay with a valid Medicare Severity-Diagnosis Related Group (MS-DRG) and with an admission date on or after the service date of the new osteoporotic fracture. The qualifying inpatient stay must have had an admission date that was later than any previously identified inpatient stays' discharge dates; the inpatient stay must have had a discharge date earlier than any future inpatient stay. See Appendix D for further information on the most common MS-DRGs for acute inpatient hospitalizations following a fracture.
3. Bone mineral density (BMD) tests. BMD tests provided during fracture episodes were identified by the presence of a BMD test procedure code (see Appendix C for specific codes) on any claim with a date of service between January 1, 2014, and December 31, 2017.
4. Beneficiaries who became dual eligible. Beneficiaries who became dual eligible (i.e., those qualifying for both Medicare and Medicaid benefits) during fracture episodes were identified. A beneficiary's dual eligibility status was determined by calendar month and year based on the CMS Master Beneficiary Summary File (MBSF).[94]
5. Beneficiaries who became institutionalized. Beneficiaries who became institutionalized during fracture episodes were identified. A beneficiary's institutionalized status during the study period was determined monthly. If a beneficiary had six consecutive months in a nursing facility within the year before or after a given month, they were considered institutionalized in that month. A beneficiary in a nursing facility was identified as any month with a nursing facility evaluation and management (E&M) claim (see Appendix C for specific codes) within the month or the prior 30 days.
6. New pressure ulcers. New pressure ulcers during fracture episodes were identified by the presence of an ICD-9-CM or ICD-10-CM diagnosis code for ulcers (see Appendix C for specific codes) in any position on a qualified claim. A clean period of 60 days was applied (i.e., no qualified claim can be observed with dates of service within the preceding 60 days for the same beneficiary with an ulcer diagnosis code in any position).
7. Subsequent new fractures. Subsequent fractures of body parts other than the body part fractured in the new osteoporotic fracture (i.e., a new fracture) were identified during fracture episodes. A new fracture was defined as an osteoporotic fracture of a different body part or of the same body part but different side of the body (if applicable to the fracture type and if the side of the new osteoporotic fracture can be determined) from the type of new osteoporotic fracture. Subsequent fractures were identified only seven days or more following the new osteoporotic fracture event so that subsequent fractures were distinct occurrences and not part of the new osteoporotic fracture.

8. Subsequent refractures. Subsequent osteoporotic fractures of the same body part as the new osteoporotic fracture (i.e., a refracture) were identified during fracture episodes. A refracture was defined as a subsequent fracture of the same body part or potentially same body part (if the side of the body of the new osteoporotic fracture cannot be determined) as the type of new osteoporotic fracture.
9. Death. Beneficiaries who died during fracture episodes were identified using the CMS MBSF.[94] The month of death was identified as a termination status for Part A and Part B coverage of death.

Confidence intervals for the proportion of beneficiaries who had key post-fracture events during their osteoporotic fracture episodes were calculated based on the mean and standard deviation of the sampling distribution of each proportion.

Comparisons of rates throughout the report have been age- and sex-adjusted to a consistent demographic distribution. This includes comparisons between:

- Annual rates of new osteoporotic fractures for male versus female Medicare FFS beneficiaries.
- Two-year rates of new pressure ulcers for Medicare FFS beneficiaries with a new osteoporotic fracture versus all Medicare FFS beneficiaries.
- Annual mortality rates for Medicare FFS beneficiaries with a new osteoporotic fracture versus all individuals aged 65 and older in the United States.
- Annual rates of subsequent fractures for Medicare FFS beneficiaries with a new osteoporotic fracture versus annual rates of new osteoporotic fractures for all Medicare FFS beneficiaries.

ANALYSIS OF COST AND UTILIZATION

We analyzed cost and utilization data for Medicare FFS beneficiaries identified with a new osteoporotic fracture in 2015 during a follow-up period that lasted up to two to three years or through death. Costs were defined by service category according to Milliman's 65+ Health Cost Guidelines (HCGs). The allowed PPPM amounts and cost relativities presented in Figures 10 and 12 above, respectively, were adjusted to 2015 for annual Medicare FFS cost trends. These trends are published by CMS and are follows:

SERVICE CATEGORY	2014-2015 COST TREND	2015-2016 COST TREND	2016-2017 COST TREND
Inpatient Facility	1.40%	0.90%	0.90%
Outpatient Facility	2.20%	-0.30%	1.70%
Professional	0.25%	0.80%	0.50%
Skilled Nursing Facility	2.00%	1.20%	2.40%
Home Health Care and Private Duty Nursing	-0.70%	-1.40%	-0.70%
Other	1.50%	-0.40%	0.70%

Source: Centers for Medicare and Medicaid Services (CMS) FFS Cost Trends, 2014-2017.[95,96]

Comparisons of allowed cost throughout the report have been age- and sex-adjusted to a consistent demographic distribution. This includes comparisons between:

- Average allowed PPPM cost in the year following a new osteoporotic fracture for Medicare FFS beneficiaries with a new osteoporotic fracture versus average allowed PMPM cost in 2015 for all Medicare FFS beneficiaries.

REGRESSION ANALYSES

The incremental cost of a subsequent fracture was estimated using a regression methodology by comparing costs in the 180-day period following a subsequent fracture for beneficiaries who have a subsequent fracture to a similar 180-day period for beneficiaries without a subsequent fracture. The recycled predictions method of analysis was used to control for potential underlying differences in population risk characteristics between the population of beneficiaries with subsequent fractures and the population of beneficiaries with no subsequent fracture.

To estimate the cost of a subsequent fracture (including both new fractures and refractures), we compared the 180-day period costs for beneficiaries who had a subsequent fracture (referred to as the case group) with beneficiaries who did not have a subsequent fracture (referred to as the control group):

1. Identifying cases. To ensure that we were reflecting a full 180-day period after the "true" or "shadow-assigned" subsequent fracture date, we removed beneficiaries who did not satisfy the following two requirements:
    a. The beneficiary remained alive for 180 days including and following the subsequent fracture.
    b. The beneficiary's subsequent fracture occurred at least 180 days prior to the end of the study period (December 31, 2017).
2. Identifying controls. To identify the control group, we assigned "shadow" subsequent fracture dates to patients with a new osteoporotic fracture, but no subsequent fracture. The shadow fracture dates were chosen by sampling from the distribution of the number of days between the new osteoporotic fracture date and the subsequent fracture date for the case group with the same new osteoporotic fracture type and age band as the potential control. We chose to match within age band as patients of different ages had very distinct costs and fracture-related events, such as acute inpatient hospitalizations and new institutionalizations in prior analyses. We chose to match within new osteoporotic fracture type as different new osteoporotic fractures had varying recovery times, with associated costs potentially persisting beyond the date of a subsequent fracture.

    To ensure that the distribution of shadow subsequent fracture dates closely matched the distribution of actual subsequent fracture dates, we:
    a. Constructed all possible valid controls with 180 days of follow-up after the shadow subsequent fracture date for each combination of age band and new osteoporotic fracture type.
    b. Randomly sampled controls for each subsequent fracture date. For example, if there were five subsequent fracture cases with a subsequent fracture 60 days after the new osteoporotic fracture, we randomly selected five valid controls with a shadow subsequent fracture date of 60 days after the new osteoporotic fracture.
    c. Randomly sampled the appropriate number of valid controls with the next-highest shadow subsequent fracture date if there were no valid controls for a given subsequent fracture date. For example, if there was one actual case with a subsequent fracture date of 300 days after the new osteoporotic fracture and no valid controls with a shadow subsequent fracture date of 300 days after the new osteoporotic fracture, but five valid controls with a subsequent fracture date of 290 days after the new osteoporotic fracture, then we randomly selected one control with a subsequent fracture date of 290 days after the new osteoporotic fracture.
    d. Required that each beneficiary was sampled at most one time for each age band and/or new osteoporotic fracture type control group.

    After identifying controls, we calculated allowed costs in the 180 days including and following the shadow subsequent fracture date.
3. Estimating the cost of subsequent fractures. We estimated the costs associated with subsequent fractures using generalized linear models with a log-link and gamma distributed errors and the recycled predictions method. Controls with $0 in allowed costs were assigned $0.01 of allowed costs. The regression models included the following covariates:
    a. Presence of a subsequent fracture
    b. New osteoporotic fracture type

c. Age band

d. Sex

e. Geographic region of residence

f. Beneficiary type (i.e., beneficiaries with metastatic cancer or bone cancer, beneficiaries with nonmetastatic or non-bone cancer, beneficiaries with ESRD, or all other beneficiaries)

g. Dual eligibility status as of January 2015

h. Institutionalized status as of January 2015

i. Presence of an osteoporosis diagnosis between 2014 and 2017

j. Count of CMS Hierarchical Condition Categories (CMS-HCCs) in 2014

See Appendix D for further information on the regression coefficients.

After running each regression, we predicted 180-day costs, first assuming that no patients had a subsequent fracture, and then assuming that all patients had a subsequent fracture. We then estimated the cost associated with each subsequent fracture by calculating the incremental predicted 180-day cost for each beneficiary, and then averaging the incremental costs across patients. We used bootstrapping to calculate 95% confidence intervals for mean-adjusted incremental costs by:

a. Generating 5,000 random samples (with replacement) for each new osteoporotic fracture type (and one with all new osteoporotic fracture types).

b. Estimating a regression in each random sample to generate variation in regression coefficients.

c. Implementing recycled predictions to calculate the mean-adjusted incremental cost in each sample.

d. Calculating the 95% confidence intervals from the distribution of mean-adjusted incremental costs.

4. Normalizing costs. The Medicare-allowed claims costs were normalized to 2015 for trend. This adjustment was based on the medical care component of the Consumer Price Index (CPI) from the U.S. Bureau of Labor Statistics (BLS).

The estimate of the total 180-day cost of subsequent fractures that were incurred during a follow-up period that lasted up to two to three years, in which the patient survives for at least 180 days after the subsequent fracture, was determined as the product of the estimated per-fracture 180-day incremental medical cost of a subsequent fracture (as determined by the regression analysis) and the estimated count of Medicare FFS beneficiaries who suffered a subsequent fracture and survived for at least 180 days after the subsequent fracture. Confidence intervals for the estimated total incremental cost of subsequent fractures reflect only variation in the per-fracture cost and were calculated by varying the direct per-fracture incremental 180-day medical cost of preventable subsequent fractures between the lower bound and upper bound of the 95% confidence intervals by fracture type shown in Figure 13 above.

SAVINGS ANALYSIS ON PREVENTABLE SUBSEQUENT FRACTURES

These estimates of the cost savings from potentially preventable subsequent fractures were developed using several assumptions and model parameters, including:

- The new osteoporotic fracture incidence per 10,000 Medicare FFS beneficiaries in 2015, derived from our claims data analysis and provided in Figure 1 above.
- Estimates of the 2015 national Medicare FFS beneficiary count from the Kaiser Family Foundation.[69]
- The percentage of new osteoporotic fracture cases with a subsequent fracture in which the patient survived at least 180 days following the subsequent fracture, as derived from our claims data analysis.

- Assumed percentages of subsequent fractures that could potentially be avoided based on our review of the literature on secondary prevention models of care for fractures. We assumed that 5%, 10%, and 20% of subsequent fractures could be avoided under the low, moderate, and high savings scenarios, respectively.
- The incremental 180-day cost of a subsequent fracture, in which the patient survived at least 180 days following the subsequent fracture, as derived from our claims data analysis and shown in Figure 13 above.
- The estimated cost of a BMD test following a new osteoporotic fracture of $75, which was derived from the actual average allowed cost of providing a BMD test to a Medicare FFS beneficiary following a new osteoporotic fracture in 2015.
- Assumed percentages of additional new osteoporotic fracture cases in which a subsequent BMD test was provided over current utilization under the implementation of a secondary fracture prevention program. We assumed that a subsequent BMD would be provided in 10%, 30%, and 50% of new osteoporotic fracture cases over current utilization under the low, moderate, and high savings scenarios, respectively.

Confidence intervals for the estimated net cost savings reflect only variation in the per-fracture cost and were calculated by varying the direct per-fracture incremental 180-day medical cost of preventable subsequent fractures between the lower bound and upper bound of the 95% confidence intervals by fracture type shown in Figure 13 above.

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