MILLIMAN RESEARCH REPORT

Medicare cost of osteoporotic fractures – 2021 updated report

The clinical and cost burden of fractures associated with osteoporosis

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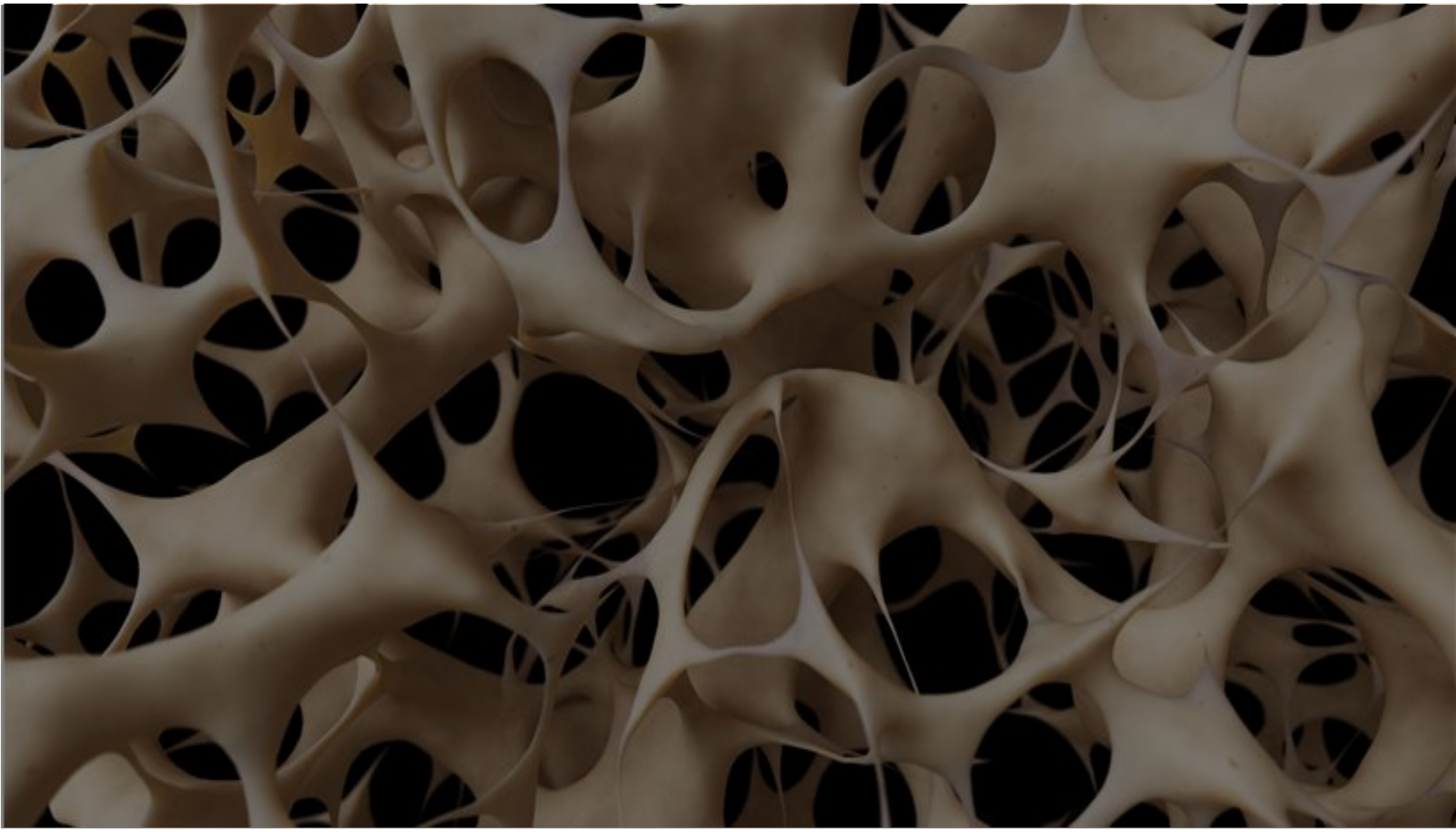

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Appendix C and Appendix D can be found in supplemental materials and are available online, along with state-specific issue briefs with key findings from each state.

EXECUTIVE SUMMARY

OSTEOPOROSIS OVERVIEW

According to the National Institutes of Health, osteoporosis 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 low-impact bone fractures associated with weak bones caused by osteoporosis and are not caused by high-impact or high-trauma events. A common example of an osteoporotic fracture 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] 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 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] and death.[3]

The burden of osteoporosis may be reduced through both primary and secondary prevention. 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 modifiable 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

Milliman was engaged by the National Osteoporosis Foundation to study the economic and clinical burden of new osteoporotic fractures among Medicare beneficiaries. We report on new osteoporotic fractures that occurred in 2016 in the Medicare fee-for-service (FFS) and Medicare Advantage populations using information from a large administrative medical claims database. We focus on "new" osteoporotic fractures, which are incident fracture events that are newly diagnosed and not associated with a high-impact event. We also separately report on the state-level economic and clinical burden of new osteoporotic fractures for each of the 50 states in state-specific issue briefs available online.

This report follows our September 2019 report, *Medicare cost of osteoporotic fractures*. The findings in this updated report were informed by the availability of updated and expanded data, diagnosis coding improvements, and changes in the methodology used in the analysis of data as detailed below.

- In this updated analysis, we use both more recent data as well as a larger sample of Medicare FFS beneficiaries as compared to the September 2019 analysis. For this report, new osteoporotic fractures were identified in administrative claims data from 100% of Medicare FFS beneficiaries in 2016. In contrast, the 2019 analysis relied on the 5% sample data from the Medicare Limited Data Set (LDS) claims files for 2015, which includes Medicare FFS paid claims generated by a statistically balanced 5% sample of Medicare FFS beneficiaries.
- The International Classification of Diseases (ICD) codes were revised and transitioned from ICD-9-CM to ICD-10-CM on October 1, 2015. ICD-10 offers greater specificity and movement toward more accurate and detailed diagnoses. Specifically, the use of ICD-10-CM diagnosis codes for identifying beneficiaries with fractures supports more accurate identification of new fractures and initial fracture care encounters versus encounters for subsequent care for prior or pre-existing fractures. In this updated analysis, only ICD-10-CM diagnosis codes were used to identify fractures that occurred in 2016. In the September 2019 analysis, fractures in 2015 were identified using a mix of both ICD-9-CM and ICD-10-CM diagnosis codes, as the transition to the ICD-10 system occurred in the midst of the study period. As ICD-9-CM diagnosis codes do not distinguish initial encounters for

fracture treatment from subsequent fracture care, it is possible that some of the fractures identified and counted as "new" in the 2019 analysis were actually prior fractures for which the patient had been previously treated and then had an extended period without fracture-related follow-up. While a lookback period with no documented fracture diagnosis codes was required in both analyses to try to ensure that the incident fracture was actually new (i.e., six months with ICD-10-CM initial fracture encounter codes and 12 months with ICD-9-CM fracture codes), it is possible that some of the fractures identified as "new" in the 2019 report (under the old coding system) were not new but rather pre-existing fractures. In other words, the implementation of ICD-10-CM and resulting greater specificity in identifying new fractures may have led to an apparent decrease in the number of new fractures between those years (even if there was not a true decrease in fracture incidence) and this change may have affected subsequent cost analyses between the two reports.

- In both the 2019 analysis and the updated analysis, our study population consisted of Medicare FFS beneficiaries covered by both Parts A and B. The 2019 report extrapolated the per-fracture cost of subsequent fractures for beneficiaries covered by both Parts A and B among all Medicare FFS beneficiaries, including those covered by Part A alone, to estimate the total cost of subsequent fractures and the potential savings from preventing subsequent fractures. However, given differences in spending between Medicare FFS beneficiaries covered by both Parts A and B versus those covered by Part A alone, this updated analysis estimates the cost of only Part A services associated with a subsequent fracture for beneficiaries covered by Part A alone. Thus, while our updated estimates are more likely to reflect the actual costs incurred by the Medicare system, we are now estimating a lower average per-fracture cost of subsequent fractures across all beneficiaries covered by both Parts A and B or Part A alone than assumed in our 2019 analysis.

Incidence of osteoporotic fractures among Medicare beneficiaries

- Fracture incidence. Approximately 1.3 million Medicare FFS beneficiaries covered by Medicare Parts A and B or Part A alone, or about 4% of the total Medicare FFS beneficiaries, suffered over 1.5 million osteoporotic fractures in 2016. In addition, we estimated that over 500,000 beneficiaries enrolled in Medicare Advantage (MA) plans suffered approximately 583,000 osteoporotic fractures in 2016, for a total of 2.1 million osteoporotic fractures in the Medicare FFS and MA populations combined. Our estimated MA fracture rate accounts for 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 that result in a lower fracture rate among MA beneficiaries.
- Common fracture types. Fractures of the spine and hip were the most common types of fractures identified, accounting for 42% of all osteoporotic fractures in 2016.
- Fracture incidence by sex. Female beneficiaries had 76% higher rates of new osteoporotic fracture than males, after adjusting for age and race. Of the 1.3 million Medicare FFS beneficiaries covered by Parts A and B or Part A alone who had at least one osteoporotic fracture in 2016, an estimated 912,000 were women and 381,000 were men.
- Fracture incidence by race/ethnicity. Fracture rates varied substantially by race/ethnicity. After adjusting for differences in age and sex, we found that the new osteoporotic fracture rate was highest among Medicare FFS beneficiaries who were North American Native (20% greater than the national average) or white (6% greater than the national average), while beneficiaries who were Black (50% lower than the national average), Asian (32% lower than the national average), or Hispanic (19% lower than the national average) had the lowest rates of new osteoporotic fractures.
- Fracture incidence by state. After adjusting for differences in age and sex, Hawaii had the lowest rate of osteoporotic fractures among the 50 states (24% lower than the national average), while Kentucky and Florida had the highest rates of osteoporotic fractures (13% and 12% higher than the national average, respectively). Over half (28 states) were within ±5% of the national average rate of osteoporotic fractures.

Key events following a new osteoporotic fracture

- Hospitalizations. 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.
- BMD tests. Only 9% of female Medicare FFS beneficiaries and 5% of male Medicare FFS beneficiaries were evaluated for osteoporosis with a bone mineral density (BMD) test within six months following a new osteoporotic fracture. Only 5% of Black Medicare FFS beneficiaries were tested in the same period following a new osteoporotic fracture.
- Subsequent fractures. An estimated 177,000 Medicare FFS beneficiaries covered by Parts A and B or Part A alone, or about 14% of those who had a new osteoporotic fracture, suffered one or more subsequent fractures within 12 months of the initial fracture.
- Pressure ulcers. Twenty percent of Medicare FFS beneficiaries with a new osteoporotic fracture developed at least one pressure ulcer within an average follow-up period of 2.3 years following an initial fracture.
- Death. Nearly one in five Medicare FFS beneficiaries died within 12 months following a new osteoporotic fracture. This accounted for approximately 245,000 deaths among Medicare FFS beneficiaries covered by Parts A and B or Part A alone who suffered an osteoporotic fracture in 2016. Of these, about 154,000 were female and 91,000 were male. Beneficiaries with a hip fracture had the highest mortality of any osteoporotic fracture: 30% died within 12 months of the fracture.

Direct medical cost of fractures

- Total cost following fracture. Allowed medical costs to Medicare for beneficiaries in the year beginning with the new osteoporotic fracture were more than twice the costs incurred in the year prior to the fracture for the same beneficiaries. Among the estimated 1.1 million Medicare FFS beneficiaries with both Parts A and B coverage who suffered a new osteoporotic fracture in 2016, the incremental annual medical cost of the new osteoporotic fracture was approximately $21,600, which included only direct costs identifiable through an administrative medical claims database and not costs related to the loss of productivity, non-skilled home care, and pharmaceutical drugs.
- 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 (+263%) as compared to the year prior to the fracture; this accounted for nearly 30% of the total incremental annual medical cost of $21,600.
- 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 $20,400 (95% confidence interval [CI]: $20,200 to $20,600) for a Medicare FFS beneficiary covered by both Parts A and B. We found that the estimated 180-day incremental cost of a subsequent fracture varied by state, from a low of $17,000 (95% CI: $15,600 to $19,000) in Arkansas to a high of $26,200 (95% CI: $22,700 to $32,800) in Wyoming.
- Total cost of subsequent fracture. An estimated 257,000 Medicare FFS beneficiaries covered by both Parts A and B suffered a subsequent fracture during a follow-up period that lasted up to three years in which the beneficiary survived for at least 180 days after the subsequent fracture, which would account for over $5.25 billion in allowed cost to Medicare FFS (95% CI: $5.20 billion to $5.30 billion). In addition to these beneficiaries covered by both Parts A and B, we estimated 32,000 beneficiaries covered only by Part A experienced a subsequent fracture in the same follow-up period. If we extrapolate the $14,700 estimated cost of Part A services associated with a subsequent fracture to these beneficiaries covered by Part A alone, this would add an estimated $475.6 million in allowed cost, bringing the total to over $5.7 billion in allowed cost for subsequent fractures suffered by Medicare FFS beneficiaries with an initial fracture in 2016. We note that the estimated total cost of subsequent fractures is lower than the $6.3 billion reported in our September 2019 report, *Medicare cost of osteoporotic fractures*, for several reasons, including changes in the composition of the Medicare FFS

population, decreases in the observed rate of new osteoporotic fractures as a result of the implementation of ICD-10 in October 2015, and that we relied on a larger sample of Medicare fee-for-service beneficiaries in our study.

Potential cost savings from reductions in subsequent fractures

- Cost savings from preventing subsequent fractures. Preventing between 5% and 20% of subsequent fractures among beneficiaries covered by both Medicare Parts A and B could have saved between $250 million (95% CI: $243 million to $258 million) and $990 million (95% CI: $962 million to $1,021 million) for the Medicare FFS program during a follow-up period that lasted up to three years after a new osteoporotic fracture, based on the historical incidence and treatment patterns of beneficiaries covered by both Parts A and B who had an osteoporotic fracture in 2016. Extrapolating to beneficiaries with Part A coverage only, preventing between 5% and 20% of subsequent fractures in this population could have added between $23 million and $89 million in savings based on the estimated cost of Part A services associated with a subsequent fracture, for a total savings across all Medicare FFS beneficiaries of between $272 million and $1.1 billion for the Medicare FFS program. 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 (including pharmacologic treatment) or additional costs of implementing a secondary fracture prevention program.

In the body of this report, we provide additional information on 949,727 Medicare FFS beneficiaries covered by both Parts A and B identified as having a new osteoporotic fracture in 2016. 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 include the following.

- Our analysis indicates that the current clinical and economic burden of osteoporosis and osteoporotic fractures is high. An estimated 2.1 million osteoporotic fractures were suffered among beneficiaries covered by Medicare in 2016, including approximately 1.5 million among individuals enrolled in Medicare FFS plans and 583,000 among individuals enrolled in Medicare Advantage plans, which have additional incentives to improve fracture care.
- 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 for a beneficiary covered by both Parts A and B was over $20,400 (95% CI: $20,200 to $20,600) during the 180-day period following the subsequent fracture. An estimated 257,000 Medicare FFS beneficiaries covered by both Parts A and B suffered a subsequent fracture during a follow-up period that lasted up to three years in which the beneficiary survived for at least 180 days after the subsequent fracture, which would account for over $5.25 billion (95% CI: $5.20 billion to $5.30 billion) in allowed cost to Medicare FFS. Extrapolating the estimated cost of Part A services associated with a subsequent fracture to the estimated number of beneficiaries with a subsequent fracture covered only by Part A would add an estimated $475.6 million in allowed cost, for a total of over $5.7 billion.
- 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 $250 million (95% CI: $243 million to $258 million) and $990 million (95% CI: $962 million to $1,021 million), respectively, for the Medicare FFS program during a follow-up period of up to three years after a new osteoporotic fracture among beneficiaries covered by both Parts A and B in 2016. Extrapolating the estimated cost of Part A services associated with a subsequent fracture to beneficiaries covered only by Part A could have led to total savings between $272 million and $1.1 billion for the Medicare FFS program among beneficiaries covered by Parts A and B or Part A alone.

METHODOLOGY

This report is an update to the September 2019 report, *Medicare cost of osteoporotic fractures*, using a larger data source and more recent data.

Using administrative medical claims data from 100% of Medicare fee-for-service beneficiaries, 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 2016. 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 three years or until death, if earlier.

We used data from a sample of Medicare Advantage beneficiaries from Milliman's Consolidated Health Cost Guidelines™ Sources Database (CHSD) to estimate the incidence of new osteoporotic fractures among beneficiaries covered by Medicare Advantage.

Milliman has developed certain models to estimate the values included in this report, including regression models to quantify the incremental cost of a subsequent fracture. The models, including all input, calculations, and output, may not be appropriate for any other purpose. We have reviewed the models, including their inputs, calculations, and outputs for consistency, reasonableness, and appropriateness to the intended purpose and in compliance with generally accepted actuarial practice and relevant actuarial standards of practice (ASOP). The models rely on data and information as input to the models. To the extent that the data and information provided is not accurate, or is not complete, the values provided in this report may likewise be inaccurate or incomplete.

Our analysis uses the race and ethnicity values in our data source. One study notes that the validity of the race and ethnicity codes in Medicare administrative data is limited, particularly for non-Black beneficiaries. Research has shown that Medicare beneficiaries' race/ethnicity is often misclassified and future work is needed to improve the accuracy of this data.[10] To the extent that the race/ethnicity data provided in the Medicare 100% Research Identifiable Files is not accurate, the results provided by race/ethnicity in this report may likewise be inaccurate.

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 osteoporotic 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.

BACKGROUND

For background on osteoporosis, including discussion on efforts to address osteoporosis, please refer to our September 2019 report, *Medicare cost of osteoporotic fractures*.

RESULTS

This report provides information on the demographic characteristics and medical costs of 949,727 Medicare FFS beneficiaries who had new osteoporotic fractures in 2016. We excluded new fractures associated with a high-trauma event, as those fractures might not have been associated with bone fragility. The analysis included determining 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 2016 and continued until the earlier of December 31, 2018 (up to two to three years), or death. We refer to this period of time as the "osteoporotic fracture episode," which lasted an average of 2.3 years. We also estimate the osteoporotic fracture incidence among Medicare Advantage (MA) beneficiaries.

Our analysis of administrative medical claims data 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. Throughout this report, we extrapolate our findings related to osteoporotic fracture incidence from Medicare FFS beneficiaries with both Parts A and B coverage to the full population of Medicare FFS beneficiaries in 2016, including those with only Part A coverage.

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

GLOSSARY OF KEY TERMS

Osteoporotic fracture: A newly diagnosed osteoporosis-related fracture that is not associated with a high-trauma event.

New osteoporotic fracture: A beneficiary's first osteoporotic fracture in 2016 that initiates the osteoporotic fracture episode.

Osteoporotic fracture episode: The period of time following a beneficiary's new osteoporotic fracture in 2016 until the earlier of December 31, 2018 or death (up to two to three years).

Subsequent fracture: An osteoporotic fracture suffered by a beneficiary following their new osteoporotic fracture.

Subsequent new fracture: A subsequent fracture of a different body part or of the same body part but different side of the body (if the side of the body can be determined) as the type of new osteoporotic fracture.

Subsequent refracture: A subsequent fracture of the same body part or potentially same body part (if the side of the body cannot be determined) as the type of new osteoporotic fracture.

OSTEOPOROTIC FRACTURE INCIDENCE

Approximately 1.3 million Medicare FFS beneficiaries suffered at least one osteoporotic fracture in 2016. Of these, the majority were female (912,000 beneficiaries, or 71% of all who had at least one osteoporotic fracture). About one in three beneficiaries who suffered at least one osteoporotic fracture in 2016 were aged 74 to 85 years (419,000 beneficiaries).

In total, 354.9 new osteoporotic fractures per 10,000 Medicare FFS beneficiaries were identified for 10 regions of the body (i.e., fracture types) in 2016 (Figure 1). A beneficiary's first osteoporotic fracture in 2016 was used as the trigger event (i.e., a "new osteoporotic fracture") for post-fracture analysis, which includes analysis of subsequent osteoporotic fractures.

We also examined the incidence of new osteoporotic fractures among a sample of Medicare Advantage (MA) beneficiaries in 2016 using the Consolidated Health Cost Guidelines™ Sources Database (CHSD). By adjusting for known differences in age and sex between Medicare FFS and MA beneficiaries, as well as an estimate of the reduced new osteoporotic fracture rates due to healthcare management and selection of MA plans, we estimated that approximately 500,000 MA beneficiaries suffered over 583,000 new osteoporotic fractures among the 17.7 million MA beneficiaries in 2016.

A recent study found that U.S. managed care enrollees, including MA beneficiaries, aged 65 and older had fracture rates of 22.66 and 11.39 per 1,000 for females and males, respectively, in 2016.[11]

FIGURE 1: INCIDENCE OF NEW OSTEOPOROTIC FRACTURES AMONG MEDICARE BENEFICIARIES IN 2016

	MEDICARE FFS	MEDICARE ADVANTAGE	TOTAL MEDICARE PROGRAM
Estimated Beneficiaries, 2016*	36,400,000	17,700,000	**54,100,000**
Percent of All Beneficiaries	67%	33%	**100%**
Rate of New Osteoporotic Fractures per 10,000	354.9	283.4	**331.5**
Estimated Beneficiary Count with at least One New Osteoporotic Fracture in 2016**	1,292,700	502,100	**1,794,700**
Estimated Osteoporotic Fractures in 2016	1,518,200	583,200	**2,101,400**

* Reflects the count of unique beneficiaries with full year of coverage or until death. For Medicare FFS, beneficiaries with both Parts A and B or Part A alone coverage were included.
** Estimated by extrapolating our calculated fracture rate for Medicare FFS beneficiaries with both Parts A and B coverage to those covered with Part A alone.

The rate of new osteoporotic fractures per 10,000 Medicare FFS beneficiaries in 2016 (Figure 1) is approximately 9% lower than the 2015 rate we reported in our September 2019 report, *Medicare cost of osteoporotic fractures*, after adjusting for age and sex. However, we believe fracture incidence had not declined significantly between 2015 and 2016 and that the lower figure is due to changes in coding systems. For our analyses, we relied on diagnosis codes reported on administrative claims to identify fracture types. In our original analysis, we identified fractures that occurred in 2015 using a mix of ICD-9-CM codes, which do not distinguish initial encounters for fracture treatment from follow-up fracture care, and ICD-10-CM codes, which do distinguish initial encounters from subsequent care for the healing process or to manage fracture sequelae. In ICD-10-CM beginning October 1, 2015, initial encounter fracture diagnosis codes are reported when the patient is receiving active treatment for the condition, such as surgical treatment, emergency department care, or evaluation and continuing treatment by the same or a different physician; we require a 6-month period with no fracture diagnosis codes for fractures identified with an ICD-10-CM initial encounter code. While in the prior analysis we required an expanded 12-month period with no ICD-9-CM fracture diagnosis codes of the same body region in order to identify new fractures occurring prior to October 1, 2015, it is possible that some of the newly identified fractures were actually previous fractures for which the patient was initially treated and subsequently had a long period without fracture-related care or follow-up. The implementation of ICD-10-CM supported greater specificity in identifying new fractures, which likely reduced the rate.

Figure 2 provides the rate of all osteoporotic fractures per 10,000 Medicare FFS beneficiaries, including the beneficiary’s first new osteoporotic fracture and subsequent fractures in 2016.

FIGURE 2: INCIDENCE OF OSTEOPOROTIC FRACTURES AMONG MEDICARE FFS BENEFICIARIES BY FRACTURE TYPE IN 2016

FRACTURE TYPE	OSTEOPOROTIC FRACTURE RATE PER 10,000 MEDICARE FFS BENEFICIARIES	ESTIMATED OSTEOPOROTIC FRACTURE CASES IN 2016*	PERCENT OF ANNUAL OSTEOPOROTIC FRACTURE CASES IN 2016
Hip	71.7	261,000	17%
Distal Femur Shaft/Distal Femur	24.3	88,700	6%
Pelvis/Sacrum	23.4	85,300	6%
Tibia/Fibula	41.7	151,800	10%
Humerus	39.2	142,800	9%
Radius/Ulna	16.3	59,400	4%
Distal Radius/Ulna	37.9	138,000	9%
Clavicle	9.5	34,500	2%
Spine	103.3	376,100	25%
Rib	49.6	180,600	12%
Total	**416.9**	**1,518,200**	**100%**

* Estimated by extrapolating our calculated fracture rate for Medicare FFS beneficiaries with both Parts A and B coverage to those covered with Part A alone.

The Figure 2 results are generally consistent with a recent study by Lewiecki et al.[12] that found the annual incidence of hip fractures was approximately 73.0 per 10,000 Medicare beneficiaries in 2015 compared to our figure of 71.7. Amin et al.[13] 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 compared to our figure of 416.9.

Osteoporotic fractures of the spine and hip were the most common types of fracture, representing 42% of the estimated total annual osteoporotic fractures in 2016, with hip fractures accounting for 17% and spine fractures accounting for 25% of all fractures (Figure 2 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/symptomatic fractures and asymptomatic morphometric or radiographic fractures; the latter of which may be underdiagnosed and underestimated. Prior research found that hip and spine fractures accounted for 14% and 27%, respectively, of all osteoporosis-related fractures,[14] similar to our results.

An estimated 1.8 million Medicare FFS and Medicare Advantage beneficiaries suffered over 2.1 million osteoporotic fractures in 2016.

The incidence of new osteoporotic fractures in the Medicare FFS population differed substantially by sex, race/ethnicity, 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 was higher in beneficiaries who were female, institutionalized, or older (Figure 3).

FIGURE 3: INCIDENCE OF NEW OSTEOPOROTIC FRACTURES AMONG MEDICARE FFS SUBPOPULATIONS IN 2016

POPULATION SUBSET	NEW OSTEOPOROTIC FRACTURE RATE PER 10,000	ESTIMATED BENEFICIARY COUNT WITH AT LEAST ONE NEW OSTEOPOROTIC FRACTURE IN 2016 *
Total Population	**354.9**	**1,293,000**
Sex		
Female	453.3	912,000
Male	233.6	381,000
Age Band		
<65	235.2	131,000
65-74	224.2	356,000
75-84	415.0	419,000
85+	788.8	388,000
Race/Ethnicity**		
White	381.9	1,180,000
Black	166.8	52,000
Hispanic	271.8	17,000
Asian	259.6	16,000
North American Native	389.0	8,000
Other	203.3	20,000
Institutionalized Status as of January 2016		
Institutionalized	634.0	64,000
Non-Institutionalized	346.9	1,228,000
Dual Status as of January 2016		
Dual Eligible	364.6	252,000
Non-Dual Eligible	352.7	1,041,000
Beneficiary Type		
Non-Cancer/Non-ESRD Beneficiaries	329.3	930,000
Beneficiaries with ESRD	562.9	32,000
Beneficiaries with Non-Metastatic/Non-Bone Cancer	405.6	253,000
Beneficiaries with Metastatic or Bone Cancer	567.5	77,000

* Estimated by extrapolating our calculated fracture rate for Medicare FFS beneficiaries with both Parts A and B coverage to those covered with Part A alone.
** Studies have identified limitations in Medicare enrollment database race variables.[10]

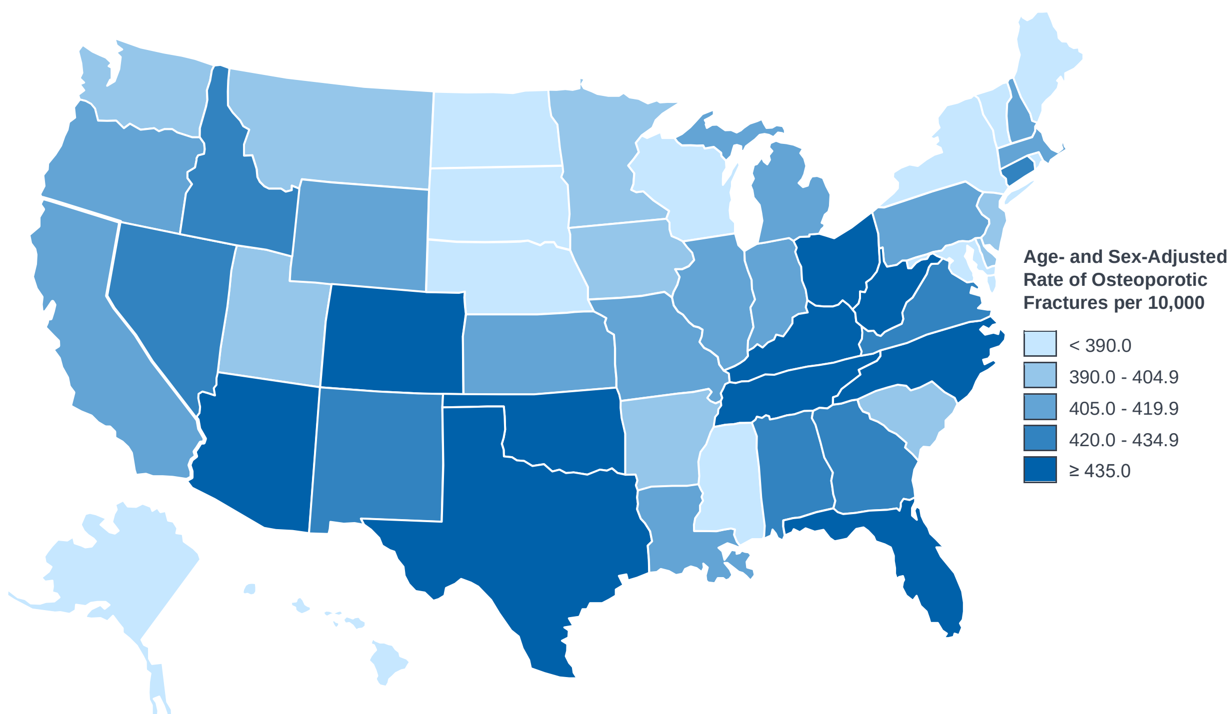
After adjusting for differences in age and race, the rate of new osteoporotic fractures for female Medicare FFS beneficiaries was 76% greater than the fracture rate for males. Beneficiaries aged 85 and older had substantially higher sex- and race-adjusted rates of new osteoporotic fractures than any other age group of beneficiaries; the rate of new osteoporotic fracture was 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),[15] had slightly higher sex- and race-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.[16] We found these beneficiaries with ESRD have a high rate of new osteoporotic fractures, with 562.9 new osteoporotic fractures per 10,000 beneficiaries. The age-, sex-, and race-adjusted new osteoporotic fracture rate for beneficiaries eligible for Medicare on the basis of ESRD was more than twice than the national average rate.

Fracture rates varied substantially by race/ethnicity. After adjusting for differences in age and sex, we found that the new osteoporotic fracture rate was highest among Medicare FFS beneficiaries who were North American Native (20% greater than the national average) or white (6% greater than the national average), while beneficiaries who were Black (50% lower than the national average), Asian (32% lower than the national average), or Hispanic (19% lower than the national average) had the lowest rates of new osteoporotic fractures. Other studies have reported racial disparities in fracture incidence and post-fracture outcomes, particularly higher rates of mortality, debility, and destitution following a fracture among Black women than among white women.[17]

We observed a disproportionately high share of new osteoporotic fractures of the tibia/fibula among Black Medicare FFS beneficiaries, while Asian beneficiaries had lower incidence of tibia/fibula fractures as a share of total fractures than the nationwide average. Fractures of the spine were less common for Black and North American Native beneficiaries compared to the nationwide average but were more common for Asian beneficiaries. Variation in osteoporotic fracture incidence by type of fracture may lead to differences in post-fracture events and healthcare costs among race/ethnicity groups.

Additionally, we identified wide variation in fracture rates among the 50 states (Figure 4). After adjusting for differences in age and sex, Hawaii had the lowest rate of osteoporotic fractures (24% lower than the national average); Kentucky and Florida had the highest rates of osteoporotic fractures (13% and 12% higher than the national average, respectively). Over half (28 states) were within ±5% of the national average rate of osteoporotic fractures (416.9 per 10,000 beneficiaries; Figure 2 above). Appendix C provides additional data on the osteoporotic fracture rates among Medicare FFS beneficiaries in 2016 by select types of fracture for each state. Key findings from this analysis for each state can be found in state-specific issue briefs available online.

FIGURE 4: AGE- AND SEX-ADJUSTED RATE OF OSTEOPOROTIC FRACTURES AMONG MEDICARE FFS BENEFICIARIES BY STATE



BONE MINERAL DENSITY TESTING FOLLOWING A FRACTURE

We found that only 8% of Medicare FFS beneficiaries who had a new osteoporotic fracture received a BMD test within six months following a new osteoporotic fracture when the risk of suffering a subsequent fracture—thus the need for treatment and action—was highest. BMD testing rates varied by sex; only 9% of female Medicare FFS beneficiaries and 5% of male Medicare FFS beneficiaries received a BMD test within six months following a new osteoporotic fracture. Medicare FFS beneficiaries who were Black were least likely to receive a BMD test within six months after a new osteoporotic fracture; only 5% of Black Medicare FFS beneficiaries received a BMD test within six months compared to 8% across all race/ethnicities. Twenty-two percent of Medicare FFS beneficiaries received a BMD test during their full osteoporotic fracture episode (that lasted up to three years). Appendix C provides additional data on key health outcomes, including BMD testing, following a new osteoporotic fracture by race/ethnicity. We did not measure pharmaceutical treatment for osteoporosis after a new osteoporotic fracture, 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.

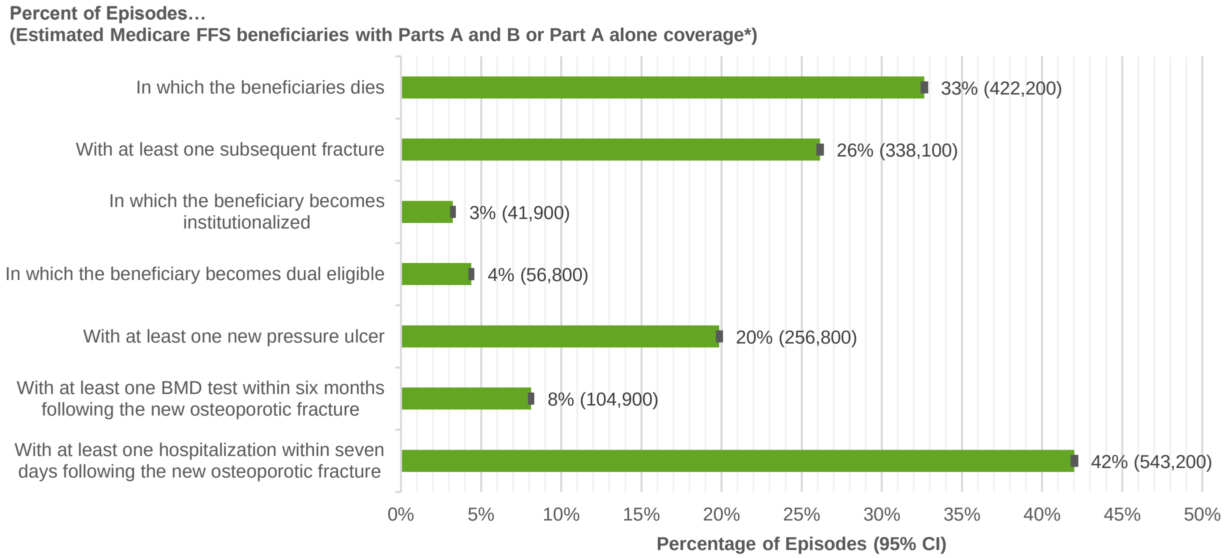
The National Committee for Quality Assurance (NCQA) provides information on the testing or treatment rates in women enrolled in Medicare Advantage (MA) plans who had a fracture.[18] By achieving a high rate of osteoporosis testing and/or treatment following a woman's fracture, MA plans may earn a higher overall star rating. Plans that earn an overall star rating of four or higher are eligible to receive a quality bonus payment. For 2019, plans that test or treat for osteoporosis in at least 78% of women enrollees aged 67 to 85 within six months after a fracture earn credit for the highest level of performance (i.e., five stars) on this measure, which contributes to the overall star rating.[19] Since 2007, star scores for osteoporosis testing or treatment have improved in MA plans. In 2017, 47% and 39% of women received *either* 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.[18] While improved, the overall MA plan rate remains below the rate of performance on other MA plan measures of secondary prevention, such as the 80% performance observed on the Healthcare Effectiveness Data and Information Set (HEDIS) measure, "Persistence of Beta-Blocker Treatment After a Heart Attack," which focuses on treatment rates.[20]

The HEDIS healthcare performance measure, "Osteoporosis Management in Women Who Had a Fracture," evaluates the proportion of women aged 65 to 85 who received *either* appropriate evaluation or treatment (i.e., BMD test or prescription for a drug to treat osteoporosis) in the six months after a fracture. This HEDIS measure is an MA plan star rating measure, contributing to an overall rating of the plan's quality and performance.[21] Osteoporosis management is measured by the NCQA as *either* a BMD test or a prescription for a drug used to treat osteoporosis.[18] 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, along with certain beneficiaries with high risk for subsequent fractures—including those who are institutionalized, those with frailty, those in hospice, and those with advanced illness—as well as 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

An osteoporotic fracture leads to a host of negative and costly health consequences, including hospitalization, additional bone fractures, institutionalization, and death. Analysis of Medicare claims data demonstrates the significant and costly impact of osteoporotic fractures on Medicare beneficiaries. Figure 5 shows the proportion of beneficiaries who had key post-fracture events during their osteoporotic fracture episodes, which extended from their new osteoporotic fractures in 2016 through December 31, 2018, or until death if earlier.

FIGURE 5: PROPORTION OF MEDICARE FFS BENEFICIARIES WITH A NEW OSTEOPOROTIC FRACTURE IN 2016 WHO HAD KEY POST-FRACTURE EVENTS DURING THEIR OSTEOPOROTIC FRACTURE EPISODES (N=949,727)



* Estimated by extrapolating our calculated fracture rate for Medicare FFS beneficiaries with both Parts A and B coverage to those covered with Part A alone.
Note: Metrics were not adjusted for key events 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; many of these hospitalizations occurred within a week of the fracture event and were likely associated with the fracture. Over half (57%) had at least one hospitalization eight days or more after the anchor event (Figure 5).

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 10% of those with a new osteoporotic fracture of the distal radius/ulna (i.e., wrist) were hospitalized within that period (Figure 6).

FIGURE 6: PERCENTAGE OF MEDICARE FFS BENEFICIARIES WHO HAD AT LEAST ONE ACUTE INPATIENT HOSPITALIZATION WITHIN A WEEK FOLLOWING A NEW OSTEOPOROTIC FRACTURE

FRACTURE TYPE	0-7 DAYS AFTER FRACTURE EVENT	ESTIMATED BENEFICIARY COUNT WITH AN ACUTE INPATIENT HOSPITALIZATION WITHIN 0-7 DAYS AFTER FRACTURE EVENT*
Hip	92%	216,700
Distal Femur Shaft/Distal Femur	67%	23,000
Pelvis/Sacrum	56%	38,200
Tibia/Fibula	28%	40,700
Humerus	28%	34,600
Radius/Ulna	14%	6,000
Distal Radius/Ulna	10%	11,900
Clavicle	22%	6,400
Spine	35%	120,100
Rib	28%	45,400
Total	**42%**	**543,200**

* Estimated by extrapolating our calculated fracture rate for Medicare FFS beneficiaries with both Parts A and B coverage to those covered with Part A alone.

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. Additionally, we found that Black Medicare FFS beneficiaries were more likely than non-Black beneficiaries to be hospitalized within a week of a new osteoporotic fracture; 45% of Black beneficiaries were hospitalized within a week versus 42% of non-Black beneficiaries.

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 estimate that over 177,000 Medicare FFS beneficiaries covered by both Parts A and B or Part A alone, or 14% of beneficiaries who had a new osteoporotic fracture, had a subsequent fracture either of the same body part (a "refracture") or of a different body part (a "new fracture") within a year of the new osteoporotic fracture. After adjusting for differences in age and sex, the rate of subsequent fractures within one year (1,312.4 per 10,000 beneficiaries who had a new osteoporotic fracture) was over three times the annual rate of new osteoporotic fractures (354.9 per 10,000 beneficiaries). These findings confirm those from other studies that having an osteoporotic fracture identifies individuals at significantly 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.[22] 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.[23]

The table in Figure 7 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. Figure 7 shows refractures of the same (or potentially same) body part and new fractures of different body parts.

FIGURE 7: PERCENTAGE OF MEDICARE FFS BENEFICIARIES WITH A NEW OSTEOPOROTIC FRACTURE WHO HAD SUBSEQUENT FRACTURES WITHIN 12 MONTHS OF THE FRACTURE EVENT, BY FRACTURE TYPE

INITIAL FRACTURE TYPE	ESTIMATED BENEFICIARY COUNT WITH SUBSEQUENT FRACTURES FOLLOWING A NEW OSTEOPOROTIC FRACTURE IN 2016*	REFRACTURE OF THE SAME BODY PART	NEW FRACTURE OF DIFFERENT BODY PART	ANY SUBSEQUENT FRACTURE
Hip	35,300	1%	14%	15%
Distal Femur Shaft/Distal Femur	6,000	3%	14%	17%
Pelvis/Sacrum	12,100	2%	16%	18%
Tibia/Fibula	11,800	2%	6%	8%
Humerus	15,500	2%	10%	12%
Radius/Ulna	6,000	1%	13%	14%
Distal Radius/Ulna	13,400	1%	11%	12%
Clavicle	4,200	1%	13%	14%
Spine	54,600	8%	9%	16%
Rib	18,400	1%	10%	12%
Total	**177,300**	**3%**	**11%**	**14%**

* Estimated by extrapolating our calculated fracture rate for Medicare FFS beneficiaries with both Parts A and B coverage to those covered with Part A alone.
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 have a subsequent fracture within 12 months following an initial fracture.[24]

Across all beneficiaries with a new osteoporotic fracture in 2016, we found that fractures of the hip (32% of all subsequent fractures) or spine (16%) were the most common type of subsequent fractures suffered during the osteoporotic fracture episode, representing nearly half of all subsequent fractures. Subsequent fractures of the clavicle (2% of all subsequent fractures) or radius/ulna (3%) were the least common types of subsequent fractures suffered during the osteoporotic fracture episode.

By state, we found that beneficiaries in Nebraska with an initial fracture had the lowest likelihood of suffering a subsequent fracture within a year of an initial osteoporotic fracture (11% of Medicare FFS beneficiaries had a subsequent fracture within 12 months) while beneficiaries in Florida had the highest likelihood (16%). Appendix C provides additional data on key health outcomes, including subsequent fractures, following a new osteoporotic fracture by state.

Beneficiaries who suffer a new osteoporotic fracture are at high risk of subsequent fractures; the annual age- and sex-adjusted rate of subsequent fractures was over three times the rate of new osteoporotic fractures for all Medicare FFS beneficiaries.

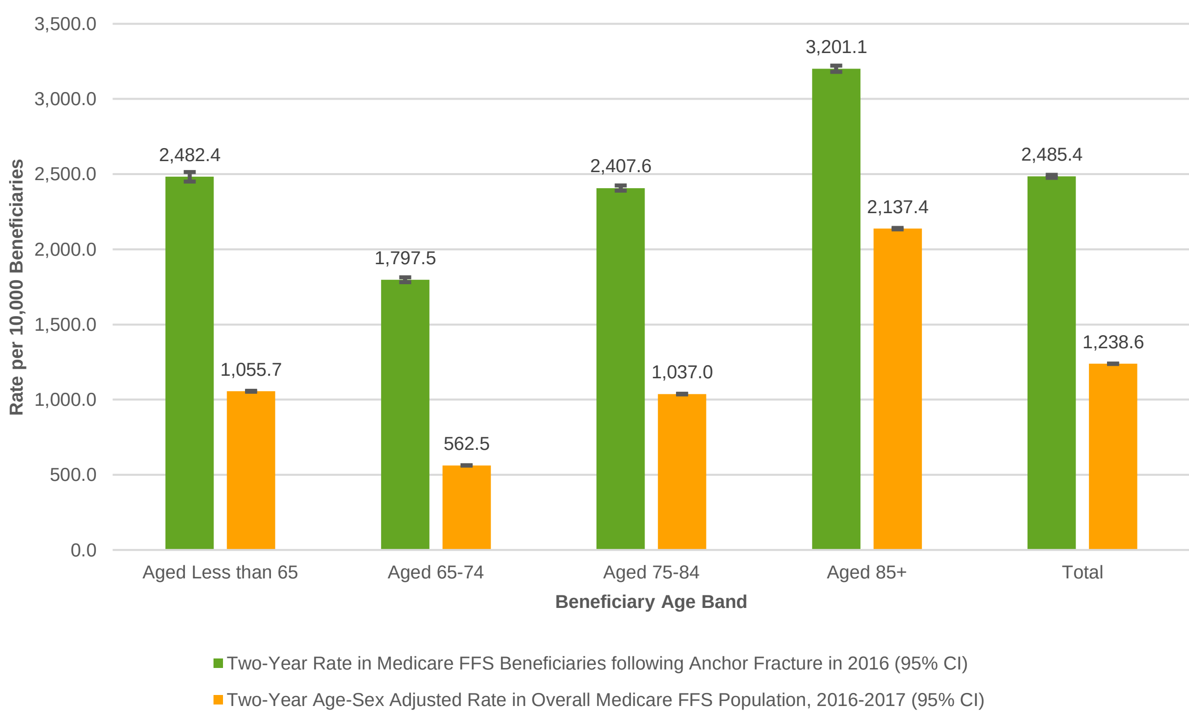
New pressure ulcers

One-in-five (20%) Medicare FFS beneficiaries, or approximately 264,000 individuals, had at least one new pressure ulcer during their osteoporotic fracture episode (Figure 5 above). This is significant because research has found that pressure ulcers are clinically difficult and expensive to manage. Pressure ulcers are considered a debilitating physical complication that leads to ulceration of the skin and prolonged pain for patients, as well as increases in health care costs for pressure ulcer-related prevention and treatment.[25]

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 8 displays the rate of new pressure ulcers over a two-year period for beneficiaries who had new osteoporotic fractures in 2016 compared to all Medicare FFS beneficiaries, adjusted for age and sex differences.

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 C.

FIGURE 8: 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

Figure 9 contains percentages 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 can provide financial assistance for Medicare’s premiums and cost sharing as well as covering sub-acute care and other care not covered by Medicare.[26] Medicare beneficiaries often earn Medicaid eligibility by becoming low-income by paying for long-term care, which is not covered by Medicare. Dual eligible beneficiaries' costs may be covered by 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. Similarly, dual eligibles made up 20% of the Medicare population but accounted for 34% of Medicare spending in 2012.[27]

Over the course of an episode of care that lasted up to three years, over 4% of Medicare FFS beneficiaries with a new osteoporotic fracture, or approximately 56,800 individuals, became eligible for Medicaid. Similarly, about 41,900 Medicare FFS beneficiaries (or over 3% of beneficiaries with a new osteoporotic fracture) became institutionalized during their osteoporotic fracture episode, which means they required the custodial care provided in a nursing home. Institutionalization may lead to a beneficiary's dual eligible status if the beneficiary spends their assets for custodial care (not covered by Medicare) 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.[28] 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.[29]

FIGURE 9: 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	2%	1%
6-12 Months After Fracture Event	1%	1%
12-18 Months After Fracture Event	1%	1%
More Than 18 Months After Fracture Event	2%	1%
Total During Episode	**4%**	**3%**

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

Death

Figure 5 above shows that 33% of beneficiaries died up to three years of a new osteoporotic fracture. About 19% of beneficiaries died within 12 months of a new osteoporotic fracture in 2016 (1,893.0 per 10,000), which was over three times greater than the average age- and sex-adjusted mortality rate among all Medicare FFS beneficiaries (622.3 per 10,000), as shown in Figure 10.

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

	AGED LESS THAN 65	AGED 65-74	AGED 75-84	AGED 85+	TOTAL
Mortality Rate of Medicare FFS Beneficiaries with a New Osteoporotic Fracture Within 12 Months of Fracture	1,041.6	1,077.9	1,738.6	3,093.7	**1,893.0**
Age- and Sex-Adjusted Annual Mortality Rate in the United States, 2016*	253.4	187.9	454.8	1,325.5	**622.3**

* Mortality rates derived from Medicare 100% Research Identifiable Files, adjusted for differences in age band and sex between total Medicare FFS population and population of Medicare FFS beneficiaries with a new osteoporotic fracture.

In 2016, about 19% of Medicare FFS beneficiaries died following a new osteoporotic fracture, which was over three times greater than the average age- and sex-adjusted mortality rate for all Medicare FFS beneficiaries.

The mortality rate varied by beneficiary age and sex, type of new osteoporotic fracture, and timing of death relative to the fracture. Figure 11 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.

Based on the total number of Medicare FFS beneficiaries with Parts A and B or Part A alone coverage in 2016, we estimated that approximately 245,000 Medicare FFS beneficiaries died within 12 months after experiencing a new osteoporotic fracture, which accounted for 18% of the 1.3 million total deaths in 2016 among Medicare FFS beneficiaries in 2016. Of the estimated 245,000 Medicare FFS beneficiaries who died within 12 months after a new osteoporotic fracture, about 154,000 were female and 91,000 were male.

The 245,000 deaths of Medicare FFS beneficiaries do not include beneficiaries covered by MA, which accounted for about 33% of the total Medicare population in 2016.

FIGURE 11: PERCENTAGE OF MEDICARE FFS BENEFICIARIES WITH A NEW OSTEOPOROTIC FRACTURE WHO 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 2016*
Hip	22%	30%	70,000
Distal Femur Shaft/Distal Femur	18%	24%	8,500
Pelvis/Sacrum	16%	23%	15,600
Tibia/Fibula	6%	10%	14,500
Humerus	10%	15%	18,600
Radius/Ulna	5%	8%	3,700
Distal Radius/Ulna	4%	8%	8,800
Clavicle	12%	19%	5,600
Spine	15%	21%	72,900
Rib	11%	17%	26,500
Total	**13%**	**19%**	**244,700**

* Estimated by extrapolating our calculated fracture rate for Medicare FFS beneficiaries with both Parts A and B coverage to those covered with Part A alone.

Beneficiaries who had a new osteoporotic hip fracture had the highest mortality rate within the 12-month period following the fracture, with nearly 30% dying in the 12-month period following the fracture. Researchers have previously reported mortality rates of 21% to 27% in the first year following a hip fracture.[30,31] 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.

We also observed variation in the mortality rates following a fracture by state. Of the Medicare FFS beneficiaries with a new osteoporotic fracture in 2016, from a low of 14% in Hawaii to a high of 21% in Rhode Island died within a year of the fracture. Differences in annual mortality may be due to differences in fracture type incidence (i.e., more severe fracture types may lead to higher mortality) or demographics, as well as differences in socioeconomics and healthcare delivery.

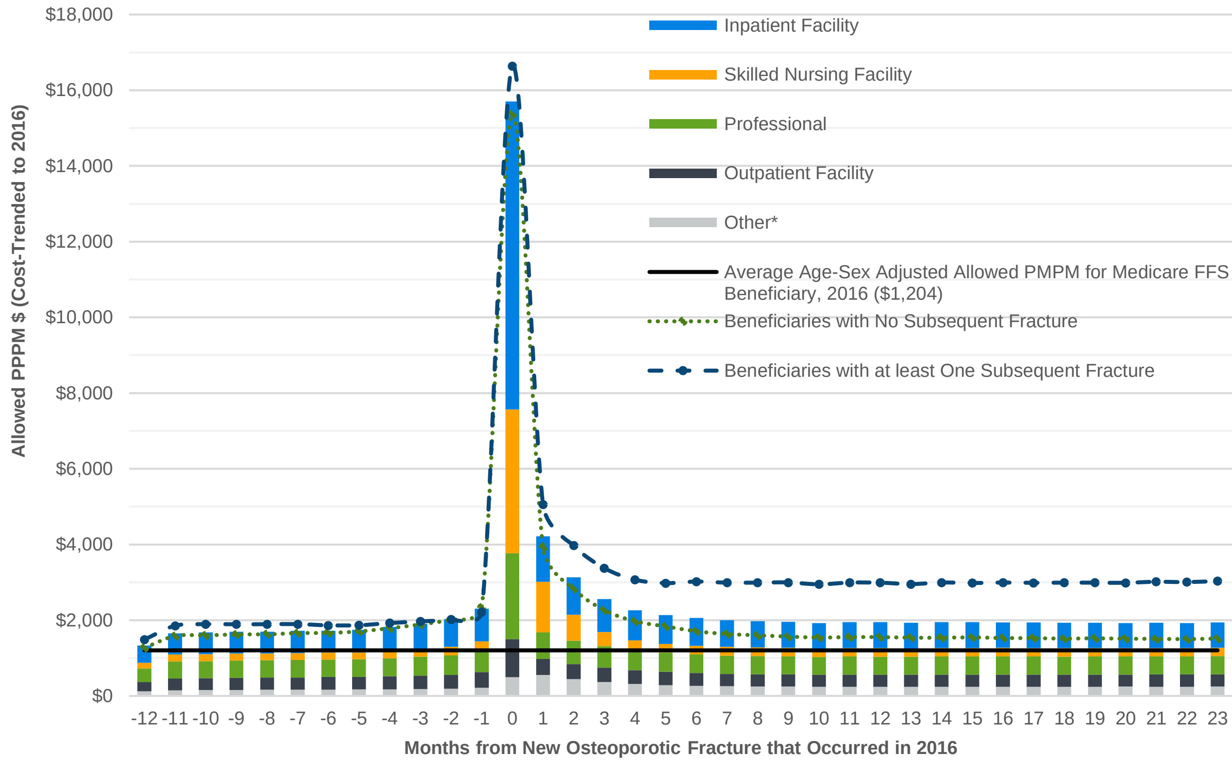
The risk of death was highest in the months immediately following a fracture. Nearly 20%, or an estimated 245,000 Medicare FFS beneficiaries, died within 12 months of a new osteoporotic fracture in 2016. For beneficiaries with a hip fracture, 30% died within 12 months of the fracture.

COST OF FRACTURE CARE

Medical care required after an osteoporotic fracture is expensive. Among the estimated 1.1 million Medicare FFS beneficiaries with both Parts A and B coverage who suffered a new osteoporotic fracture in 2016, the incremental annual allowed medical cost for osteoporotic fractures was $21,564 per beneficiary with a new osteoporotic fracture in 2016. Allowed cost is the sum of the amount paid by Medicare and the patient cost sharing.

Figure 12 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 2016, 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 2016 dollars using Medicare FFS cost trends published by the Centers for Medicare and Medicaid Services (CMS). In Figure 12, we included the average allowed per member per month (PMPM) cost for the total Medicare FFS population in 2016, adjusted for the age and sex of the beneficiaries with a new osteoporotic fracture ($1,216 PMPM).

FIGURE 12: LONGITUDINAL PPPM ALLOWED COST SUMMARY FOR MEDICARE FFS BENEFICIARIES WITH A NEW OSTEOPOROTIC FRACTURE IN 2016



* Includes home health care/private duty nursing, durable medical equipment, and hospice services.
Note: The bar graph provides the composite medical allowed PPPM cost incurred by month and service category for all Medicare FFS beneficiaries within the Medicare 100% Research Identifiable Files identified with a new osteoporotic fracture in 2016 (n = 949,727). 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 = 701,380). 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 = 248,347). The bolded level line reflects the average age- and sex-adjusted medical allowed PMPM in 2016 across all medical services for the total Medicare FFS denominator population (n = 26,727,723).

In the year prior to their new osteoporotic fracture, beneficiaries 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 ($1,775) was nearly 50% higher than the 2016 average allowed PMPM for the average Medicare FFS beneficiary ($1,204), after adjusting for differences in age and sex. Differences in comorbidities between beneficiaries with and without fractures likely contributed to these “pre-fracture” findings.

Average allowed costs are higher 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 ($2,097 per month), nearly 20% greater than the average monthly allowed cost in the year prior to the new osteoporotic fracture event ($1,775 per month), after adjusting for cost trend.

The estimated incremental annual allowed medical cost in the year following a new osteoporotic fracture among beneficiaries with a subsequent fracture during their osteoporotic fracture episode was even larger, at over $30,000 for the year following a new osteoporotic fracture compared to the year before the fracture.

Average allowed costs in the second year following the new osteoporotic fracture for beneficiaries who had no subsequent fracture eventually 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 beneficiaries who survived 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 11 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.

Figure 13 presents the difference and the average ratio of annual costs incurred between the year starting with 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 differences 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 2016, which we would expect to reduce the differences by 2% to 4%.

FIGURE 13: 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 SERVICE CATEGORY

FRACTURE TYPE	INPATIENT FACILITY	OUTPATIENT FACILITY	PROFESSIONAL	SKILLED NURSING FACILITY (SNF)	OTHER*	TOTAL
Hip	$22,344	$262	$4,545	$14,918	$3,321	**$45,389 (+199%)**
Distal Femur Shaft/Distal Femur	$14,153	$321	$3,125	$11,239	$2,521	**$31,359 (+99%)**
Pelvis/Sacrum	$9,738	$603	$2,171	$8,480	$2,775	**$23,766 (+103%)**
Tibia/Fibula	$6,942	$1,173	$2,188	$4,867	$1,521	**$16,691 (+86%)**
Humerus	$6,819	$1,546	$2,383	$4,563	$1,901	**$17,212 (+92%)**
Radius/Ulna	$3,967	$1,582	$1,842	$2,003	$1,016	**$10,410 (+66%)**
Distal Radius/Ulna	$3,138	$1,805	$2,010	$1,725	$1,030	**$9,708 (+69%)**
Clavicle	$5,144	$884	$1,534	$2,685	$1,708	**$11,955 (+55%)**
Spine	$9,107	$1,093	$2,224	$4,087	$2,010	**$18,520 (+76%)**
Rib	$6,951	$761	$1,514	$2,916	$1,373	**$13,516 (+66%)**
Total	**$10,005 (+135%)**	**$988 (+25%)**	**$2,518 (+44%)**	**$6,048 (+263%)**	**$2,005 (+100%)**	**$21,564 (+101%)**

* Includes home health care/private duty nursing, durable medical equipment, and hospice services.
Note: Annual pre-fracture cost of a given fracture type was compared to the annual post-fracture cost of the same fracture type to adjust for differences in risk between beneficiaries with different fracture types. 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 service category. For hip fractures, average costs in the year following the fracture (including the cost of the hip fracture) were nearly 200% greater ($45,389) than costs in the year prior to the new osteoporotic fracture, which was almost double the average cost differential for all fracture types ($21,564).

Our analysis shows that the increased cost in the year following the new osteoporotic fracture was mostly attributed to increases for inpatient services and skilled nursing facilities (SNFs). Increases in costs for these services accounted for more than $16,000 to this total cost differential of $21,564.

Increases in inpatient and skilled nursing facility costs accounted for more than $16,000 of the total $21,564 additional allowed medical cost in the year following a new osteoporotic fracture.

Across all beneficiaries who had an osteoporotic fracture, the cost of non-SNF inpatient facility services increased by 135%, or over $10,000, between the year before and the year after the new osteoporotic fracture (after adjusting for Medicare FFS cost trend). The average non-SNF inpatient cost increase for the fracture types we examined ranged from 73% ($3,138) for beneficiaries with a distal radius/ulna fracture to 279% ($22,344) for beneficiaries with a hip fracture.

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 2016, the cost of SNF services increased by 263%, or over $6,000, between the year before and the year following the new osteoporotic fracture, after adjusting for cost trend. For beneficiaries with a hip fracture, increases in inpatient plus SNF services added over $37,000 in annual medical costs in the year following the fracture.

COST OF A SUBSEQUENT FRACTURE

As described above, beneficiaries who experienced a subsequent fracture after a new osteoporotic fracture in 2016 had higher medical costs than those who did not have a subsequent fracture. Savings could be achieved if subsequent fractures could be avoided, perhaps through increased use of BMD testing and osteoporosis treatment.

After adjusting for differences in risk characteristics between the populations of Medicare FFS beneficiaries covered by both Parts A and B with and without a subsequent fracture, we estimated the adjusted incremental medical cost of the subsequent fracture to be about $20,400 (95% CI: $20,200 to $20,600). An estimated 257,000 Medicare FFS beneficiaries with both Parts A and B coverage suffered a subsequent fracture during a follow-up period of up to three years in which the beneficiary survived at least 180 days following the subsequent fracture. The subsequent fractures for these 257,000 beneficiaries generated over $5.25 billion in incremental allowed cost to Medicare FFS (95% CI: $5.20 billion to $5.30 billion). In addition to these beneficiaries covered by both Parts A and B, we estimated 32,000 beneficiaries covered only by Part A experienced a subsequent fracture in the same follow-up period. If we extrapolate the $14,700 estimated cost of Part A services associated with a subsequent fracture to these beneficiaries covered by Part A alone, this would add an estimated $475.6 million in allowed cost, bringing the total to over $5.7 billion in allowed cost for subsequent fractures suffered by Medicare FFS beneficiaries with an initial fracture in 2016. Appendix C provides additional data on the cost of subsequent fractures suffered by Medicare FFS beneficiaries by state.

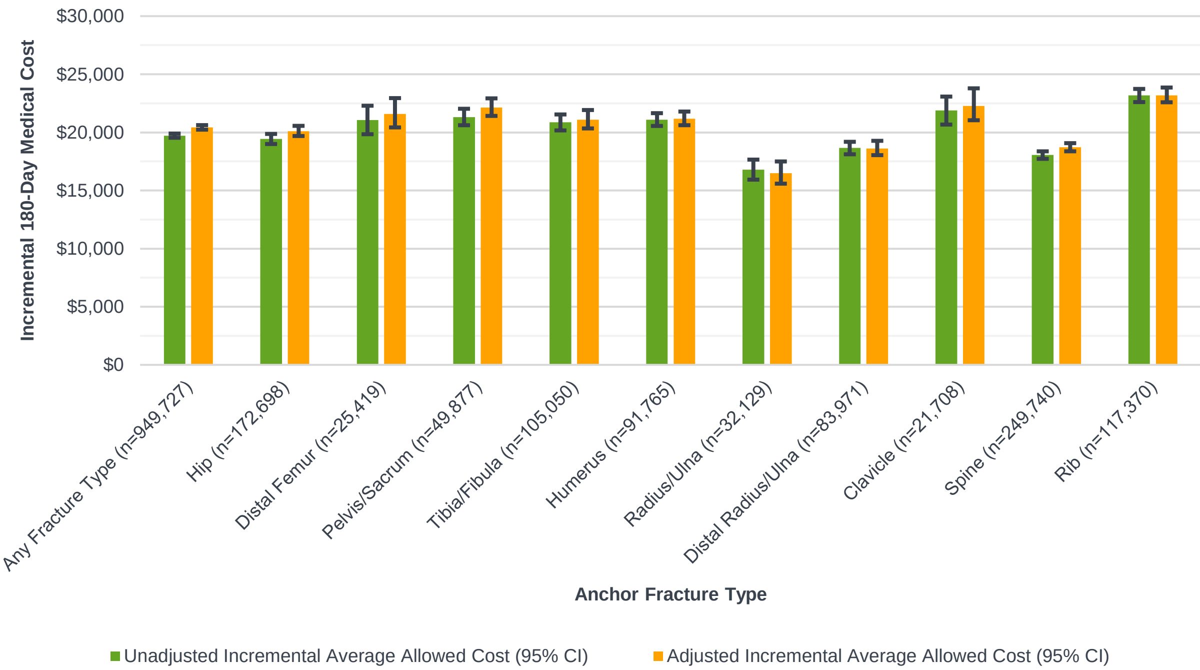
We found that the estimated 180-day incremental cost of a subsequent fracture among beneficiaries covered by both Parts A and B varied by state, from a low of $17,000 (95% CI: $15,600 to $19,000) for Arkansas to a high of $26,200 (95% CI: $22,700 to $32,800) for Wyoming. Thirty states had an incremental cost within ±10% of the nationwide average. Additional research is needed to identify the drivers of cost variation by state, but these drivers may include differences in social determinants of health, population morbidity, unit cost, and demographics by state. Findings from each state can be found in state-specific issue briefs available online.

> Approximately 290,000 beneficiaries with a new osteoporotic fracture in 2016 covered by both Medicare Parts A and B or Part A alone suffered a subsequent fracture during a follow-up period of up to three years in which the beneficiary survived at least 180 days following the subsequent fracture, generating over $5.7 billion in incremental allowed cost to Medicare.

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 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 14.

FIGURE 14: ESTIMATED INCREMENTAL 180-DAY MEDICAL COST OF SUBSEQUENT FRACTURE AMONG MEDICARE FFS BENEFICIARIES COVERED WITH PARTS A AND B 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 C 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 (in 2014 U.S. dollars) greater than the total healthcare cost for patients without a subsequent fracture.[32]

COST SAVINGS FROM PREVENTING SUBSEQUENT FRACTURES

Using our estimates of the costs of secondary fractures and assumptions informed by the literature on secondary fracture prevention, we modeled the potential savings to Medicare from preventing a portion of subsequent fractures in the Medicare FFS population. The table in Figure 15 provides a summary of the estimated national savings under three scenarios, which use different percentages for the subsequent fractures that would be prevented and also different percentages for additional BMD testing.

FIGURE 15: ESTIMATED NATIONWIDE SAVINGS FROM PREVENTING SUBSEQUENT FRACTURES AMONG MEDICARE FFS BENEFICIARIES WHO HAD A NEW OSTEOPOROTIC FRACTURE IN 2016, UNDER THREE SCENARIOS

	5% SUBSEQUENT FRACTURES AVOIDED	10% SUBSEQUENT FRACTURES AVOIDED	20% SUBSEQUENT FRACTURES AVOIDED
Estimated national Medicare FFS beneficiaries with both Parts A and B coverage with a new osteoporotic fracture in 2016	1,148,000	1,148,000	1,148,000
Estimated national new osteoporotic fracture cases with both Parts A and B with a subsequent fracture where the patient survives 180 days after the subsequent fracture	257,200	257,200	257,200
Assumed percentage of subsequent fractures that are prevented	5%	10%	20%
Estimated prevented subsequent fractures in a national Medicare FFS population with both Parts A and B	12,900	25,700	51,400
Direct per-fracture incremental 180-day medical cost of preventable subsequent fractures among beneficiaries with both Parts A and B	$20,140	$20,140	$20,140
Estimated gross savings from prevented subsequent fractures in a national Medicare FFS population with both Parts A and B	**$258,900,000**	**$517,900,000**	**$1,035,800,000**
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 among beneficiaries with both Parts A and B	$9,100,000	$27,400,000	$45,700,000
Estimated net post-testing savings from prevented subsequent fractures in a national Medicare FFS population with both Parts A and B (95% CI)	**$249,800,000 ($242,900,000 to $257,500,000)**	**$490,500,000 ($476,600,000 to $505,900,000)**	**$990,100,000 ($962,400,000 to $1,020,900,000)**
Estimated net post-testing savings from prevented subsequent fractures in a national Medicare FFS population covered by Part A alone*	$22,600,000	$44,100,000	$89,300,000
Estimated net post-testing savings from prevented subsequent fractures in a national Medicare FFS population covered by both Parts A and B or Part A alone	**$272,400,000**	**$534,600,000**	**$1,079,400,000**

* Reflects the net (i.e., post-BMD testing) savings among Medicare beneficiaries covered by only Part A by extrapolating the estimated cost of Part A services associated with a subsequent fracture to the estimated count of beneficiaries with a subsequent fracture who are covered by Part A alone.
Note: 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 and upper 95% confidence intervals by fracture type shown in Figure 14 above.

Preventing between 5% and 20% of subsequent fractures among beneficiaries covered by both Medicare Parts A and B, coupled with performing BMD tests on an additional 10% to 50% of patients with new osteoporotic fractures, could have saved between $250 million (95% CI: $243 million to $258 million) and $990 million (95% CI: $962 million to $1,021 million) for the Medicare FFS program for beneficiaries covered by both Parts A and B during a new osteoporotic fracture follow-up period of up to three years. Extrapolating the estimated cost of Part A services associated with a subsequent fracture to beneficiaries covered only by Part A could have added between $23 million and $89 million in savings when preventing between 5% and 20% of subsequent fractures among beneficiaries covered only by Part A, for a total savings between $272 million and $1.1 billion for the Medicare FFS program. This is based on the historical incidence and treatment patterns of beneficiaries who had an osteoporotic fracture in 2016. While the impact of the interventions will be spread across years, the annual savings could be between $272 million and $1.1 billion in 2016 dollars after several years of full implementation. Medicare FFS payments for Parts A and Part B benefits totaled approximately $381 billion in 2016.[33] We note that this savings estimate does not account for any increased costs of osteoporosis treatment beyond additional BMD tests, including the costs of implementing the secondary fracture prevention program or costs of pharmacologic treatment.

The estimated savings from preventing subsequent fractures among Medicare FFS beneficiaries is 12% lower than the estimated savings reported in our September 2019 report, *Medicare cost of osteoporotic fractures.* We note the following changes:

- Rate of new osteoporotic fractures: The rate of new osteoporotic fractures per 10,000 among Medicare FFS beneficiaries has decreased from that reported in our earlier report. Coding specificity improved with the implementation of ICD-10 in October 2015, and this has narrowed the identification of new osteoporotic fractures.
- Incremental cost of a subsequent fracture: The average estimated incremental cost of a subsequent fracture among beneficiaries covered by both Parts A and B has decreased by approximately 4% from our September 2019 report, driven by a reduction in the average cost of subsequent spine fractures, particularly in the first year following an initial fracture, coupled with an increase in the share of subsequent spine fractures. With the implementation of ICD-10, we now rely entirely on a 6-month lookback period to identify new fracture events (versus a 12-month lookback period used for ICD-9 codes in our original analysis) and are identifying more spine fractures due to the shorter lookback period. Many of these spine fracture events may be lower severity and thus lower cost than those identified in the original analysis.
  - In addition, in our September 2019 report, we estimated the potential savings among Medicare FFS beneficiaries assuming per-fracture costs of a subsequent fracture were consistent between those covered by both Parts A and B and those covered by Part A alone. However, given differences in spending by Medicare FFS beneficiaries covered by Part A alone, we are now estimating a lower per-fracture cost of preventable subsequent fractures among beneficiaries covered by Part A alone by extrapolating the estimated cost of Part A services associated with a subsequent fracture.
- Rate of subsequent fractures: The observed percentage of Medicare FFS beneficiaries who suffer a subsequent fracture during a follow-up period of three years in which the patient survives 180 days after the subsequent fracture has increased from our September 2019 report.
- Average cost of a BMD test following a fracture: The average cost of a BMD test following a fracture has increased from about $75 per test to $80 per test.

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 a fracture liaison service (FLS), which seeks to identify those at high risk for subsequent fracture and to improve adherence to treatment through better care coordination, may reduce the incidence of subsequent fractures and, therefore, reduce costs. Reducing primary osteoporotic fractures may also reduce the absolute incidence of subsequent fractures and reduce costs. Our modeled cost savings assume nationwide implementation of programs that achieve 5% to 20% subsequent fracture prevention, before considering the costs of additional osteoporosis treatment and operation of the FLS programs.

We note several limitations to this savings potential:

- This analysis was performed for Medicare FFS beneficiaries. 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 17.7 million individuals.
- Our estimates of the savings do not account for the cost of providing additional services beyond BMD tests, such as care coordination and referral, or other osteoporosis treatments.
- 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 for subsequent fractures or any indirect costs, which may include loss of productivity and informal caregiving.[34]
- 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 on the efficacy of programs in preventing subsequent fractures. While evidence on the outcomes of secondary fracture prevention models of care throughout the United States is limited, we observed a high degree of variability reported in the results from international programs focused on improved fracture care as discussed in the Background section of our September 2019 report, *Medicare cost of osteoporotic fractures*.

DISCUSSION

Figure 16 summarizes key findings from our analysis of osteoporotic fractures suffered by Medicare FFS beneficiaries.

FIGURE 16: SUMMARY OF KEY FINDINGS

	VALUE
Estimated count of Medicare FFS and Medicare Advantage beneficiaries who suffered an osteoporotic fracture in 2016*	1.8 million
Percentage of Medicare FFS beneficiaries with a new osteoporotic fracture in 2016 who were hospitalized within one week after the fracture	42%
Percentage of female Medicare FFS beneficiaries who were evaluated for osteoporosis with a BMD test within six months after a new osteoporotic fracture in 2016	9%
Estimated count of Medicare FFS beneficiaries who suffered one or more subsequent fractures within 12 months of an initial osteoporotic fracture in 2016*	177,300
Estimated count of Medicare FFS beneficiaries who died within 12 months after a new osteoporotic fracture in 2016*	244,700
Estimated incremental medical 180-day cost of a subsequent fracture following a new osteoporotic fracture suffered by a Medicare FFS beneficiary with both Parts A and B coverage in 2016	$20,400
Estimated total incremental medical 180-day cost of all subsequent fractures following new osteoporotic fractures during a follow-up period of up to three years following a new osteoporotic fracture in 2016 for Medicare FFS beneficiaries covered by both Parts A and B or Part A alone who survived for at least 180 days after the subsequent fracture**	$5.7 billion
Potential direct medical cost savings from preventing between 5% and 20% of subsequent fractures among Medicare FFS beneficiaries covered by both Parts A and B or Part A alone during a follow-up period of up 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**	$272 million to $1.1 billion

* Estimated by extrapolating our calculated fracture rate for Medicare FFS beneficiaries with both Parts A and B coverage to those covered with Part A alone.
** Includes subsequent fractures among beneficiaries covered by Medicare Part A alone, which is calculated by extrapolating the estimated cost of Part A services associated with a subsequent fracture to the estimated count of beneficiaries with a subsequent fracture covered by Part A alone.

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 and that there are important racial/ethnic disparities. Other studies suggest that osteoporosis is underdiagnosed due to low screening rates[35–37] and undertreated following an osteoporotic fracture.[38] 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. Among Black Medicare FFS beneficiaries, only 5% were tested within six months of a new osteoporotic fracture. According to one study, average MA rates of testing or treatment for women within six months post-fracture, which include either BMD testing or pharmaceutical therapies, were approximately 45% for 2017.[39]

Osteoporotic fractures were also a significant cost to Medicare, with an estimated 1.1 million Medicare FFS beneficiaries with both Parts A and B coverage having incurred approximately $21,600 more in the year following a new osteoporotic fracture in 2016 when compared to the year before the fracture, after adjusting for cost trend. This difference was even larger for beneficiaries who experienced a subsequent fracture. Medicare allowed expenditures for these beneficiaries was over $30,000 more in the year following a new osteoporotic fracture.

We observed significant variation by state both in the incidence of new osteoporotic fractures and in the cost of providing care following those fractures, including the cost of subsequent fractures. Hawaii had the lowest age- and sex-adjusted rate of osteoporotic fractures among the 50 states (24% lower than the national average), while Kentucky and Florida had the highest rates of osteoporotic fractures (13% and 12% higher than the national average, respectively). The estimated 180-day incremental cost of a subsequent fracture varied between $17,000 (95% CI: $15,600 to $19,000) for Arkansas to $26,200 (95% CI: $22,700 to $32,800) for Wyoming. Further research is needed to understand the geographic variation in fracture incidence and care. Key findings from each state can be found in state-specific issue briefs available online.

An osteoporotic fracture is a sentinel event that is associated with 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 2016. 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, care coordination, and treatment initiation, 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 for a beneficiary covered by both Parts A and B would be expected to lead to an estimated per-fracture savings to Medicare FFS of over $20,400 (95% CI: $20,200 to $20,600) in the 180-day 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 $272 million and $1.1 billion for the Medicare program from Medicare FFS beneficiaries with both Parts A and B or Part A alone coverage with new osteoporotic fractures in 2016 within a follow-up period that lasted up 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[40] to 80% over a four-year period.[41] One recent study found that implementation of a FLS at a tertiary care academic medical center in the United States led to high rates of treatment implementation and adherence as well as low incidence of secondary fracture, particularly among patients who remained on FLS-guided pharmacologic treatment for 12 months.[42]

Further research would help 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. Studies of the cost effectiveness of secondary fracture prevention initiatives will need to net the cost of the intervention and additional pharmaceutical treatment for osteoporosis against Medicare savings from avoided subsequent fractures.

APPENDIX A: DATA SOURCES

KEY DATA SOURCES

CMS 100% Research Identifiable Files

The Medicare 100% Research Identifiable Files contain all Medicare Parts A, B, and D paid claims for all Medicare fee-for-service (FFS) beneficiaries in the United States. Information includes county of residence, diagnosis codes, procedure codes, and diagnosis-related group (DRG) codes, along with site of service information including provider IDs. The data also provides monthly eligibility data for each beneficiary including demographics, eligibility status, and an indicator for health maintenance organization (HMO) enrollment. This data is released on an annual basis.

We used the Medicare 100% Research Identifiable Files for 2016 as the index year in which we identified beneficiaries with osteoporotic fractures. We used claims in 2015 as the lookback period for fracture events and included prospective analysis of 2017-2018 data to determine utilization and cost patterns for individuals with osteoporotic fractures in the post-fracture period.

Milliman Consolidated Health Cost Guidelines™ Sources Database

The Consolidated Health Cost Guidelines™ Sources Database (CHSD) contains proprietary historical claims experience from several of Milliman's Health Cost Guidelines data contributors. The database contains annual enrollment and paid medical and pharmaceutical services for a sample of over 20 million insured individuals covered by the benefit plans of large employers, health plans, and governmental and public organizations nationwide. We used CHSD data for 2015 and 2016 to identify new osteoporotic fractures among a sample of beneficiaries enrolled in Medicare Advantage policies.

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 2016 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).[43]

APPENDIX B: METHODOLOGY

DENOMINATOR POPULATION

The denominator population for the Medicare FFS beneficiaries identified with a new osteoporotic fracture in 2016 was defined as beneficiaries in the Medicare 100% Research Identifiable Files who met the following criteria:

- Enrolled in Medicare FFS with continuous Part A and Part B coverage from January 1, 2015, through December 31, 2018, or until death if the beneficiary died prior to December 31, 2018, but after January 1, 2016.

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 D.

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. Beneficiaries with end-stage renal disease (ESRD). Beneficiaries with ESRD were identified as beneficiaries who were eligible for Medicare on the basis of ESRD during any month between January 1, 2015, and December 31, 2018. These beneficiaries were identified using one of the following criteria:
    a. ESRD indicator
    b. Current reason for Medicare entitlement as ESRD or disability insurance benefits and ESRD
    c. Medicare status code as aged with ESRD, disabled with ESRD, or ESRD only
2. Beneficiaries with metastatic cancer or bone cancer. 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 D for specific codes) in any position on at least one qualified claim between January 1, 2015, and December 31, 2018.
3. Beneficiaries with nonmetastatic or non-bone cancer. 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 D for specific codes) in any position on at least one qualified claim between January 1, 2015, and December 31, 2018.
4. All other beneficiaries (i.e., non-cancer, non-ESRD beneficiaries). 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 extended an average of 2.3 years post-fracture through the following approach:

1. Identify bone fractures. We identified all bone fracture claims for beneficiaries in the denominator population with dates of services in 2016. A bone fracture claim was identified by a specified ICD-10-CM diagnosis code in any position on a qualified claim (see Appendix D 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-10-CM diagnosis codes specific to the type of fracture (see Appendix D 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., nonacute 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. Bone fractures in 2016 were 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) and a six-month lookback period was used. The lookback period may have extended to 2015, where we used ICD-9-CM diagnoses codes to identify bone fractures prior to October 1, 2015 (see Appendix D for specific codes).

   Beneficiaries may have multiple new bone fractures in 2016, 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 D 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 2016, which initiates the beneficiary's "osteoporotic fracture episode." Additional osteoporotic fractures for the same beneficiary later in 2016 did not initiate new osteoporotic fracture episodes; they were considered subsequent fractures.

Beneficiaries who initiated osteoporotic fracture episodes comprised the study population. Due to the underreporting of osteoporosis diagnoses,[35] 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 D for specific codes) in any diagnosis code position on a qualified claim for a service provided between January 1, 2015, and December 31, 2018. 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 2015 (see Appendix D for specific codes). See Appendix C 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.

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 D for specific codes) on any claim with a date of service between January 1, 2015 and December 31, 2018.

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).[44]

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 D 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 D 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. We did not consider different vertebrae when identifying refractures of the spine; subsequent fractures of the spine will always be considered refractures of the spine among beneficiaries with a new osteoporotic fracture of the spine regardless of the vertebral location of the refracture.
9. Death. Beneficiaries who died during fracture episodes were identified using the CMS Master Beneficiary Summary File (MBSF).[44] 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.
- Annual rates of new osteoporotic fractures among Medicare FFS beneficiaries by state versus all Medicare FFS beneficiaries nationwide.
- 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 2016 during a follow-up period that lasted up to three years or through death. Costs were defined by Medicare claim types divided by CMS, which include institutional claims (Inpatient, Skilled Nursing Facility [SNF], Home Health [HH], Hospice, and Hospital Outpatient) and non-institutional claims (Physician/Supplier-Carrier and Durable Medical Equipment). The allowed PPPM amounts and cost relativities presented in Figures 12 and 13 above, respectively, were adjusted to 2016 for annual Medicare FFS cost trends. These trends are published by CMS and are as follows:

SERVICE CATEGORY	2015-2016 COST TREND	2016-2017 COST TREND	2017-2018 COST TREND
Inpatient Facility	0.90%	0.90%	1.20%
Outpatient Facility	-0.30%	1.70%	1.40%
Professional	0.80%	0.50%	0.50%
Skilled Nursing Facility	1.20%	2.40%	1.00%
Home Health Care and Private Duty Nursing	-1.40%	-0.70%	0.10%
Durable Medical Equipment	-0.40%	0.70%	1.10%
Hospice	-1.40%	-0.70%	0.10%

Source: Centers for Medicare and Medicaid Services (CMS) FFS Cost Trends, 2015-2018.[45–47]

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 2016 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. This analysis was performed for all subsequent fractures nationwide as well as for each state.

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, 2018).

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.

    Due to sampling issues, we required a control not from the same state but from the same region for the state-specific regression analyses.

    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. <u>Estimating the cost of subsequent fractures.</u> 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. Race/ethnicity

   f. Geographic region of residence

   g. 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)

   h. Dual eligibility status as of January 2016

   i. Institutionalized status as of January 2016

   j. Presence of an osteoporosis diagnosis between 2015 and 2018

   k. Count of CMS Hierarchical Condition Categories (CMS-HCCs) in 2015

   See Appendix C 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. <u>Normalizing costs.</u> The Medicare-allowed claims costs were normalized to 2016 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 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 14 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 2016, derived from our claims data analysis and provided in Figure 1 above.
- Estimates of the 2016 national Medicare FFS beneficiary count from our analysis of the Medicare 100% Research Identifiable Files.
- 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 for a Medicare FFS beneficiary covered by both Parts A and B, in which the patient survived at least 180 days following the subsequent fracture, as derived from our claims data analysis and shown in Figure 14 above.
- The estimated cost of a BMD test following a new osteoporotic fracture of $80, 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 2016.
- 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.
- The incremental 180-day cost of a subsequent fracture for a Medicare FFS beneficiary covered by Part A alone, estimated as the cost of Part A services associated with a subsequent fracture.
- The number of Medicare FFS beneficiaries covered by Part A alone who suffered a subsequent fracture following an initial fracture in 2016, estimated assuming fracture incidence rates consistent with beneficiaries covered by both Parts A and B.

Confidence intervals for the estimated net cost savings among beneficiaries with both Parts A and B coverage 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 14 above.

FRACTURE RATE ESTIMATION AMONG MEDICARE ADVANTAGE

In order to estimate the rate of new osteoporotic fractures among MA beneficiaries in 2016, we started with the rate of new osteoporotic fractures by state among Medicare FFS beneficiaries in 2016 from the Medicare 100% Research Identifiable Files. This rate was adjusted for the following:

- Age/sex adjustment: Using the distribution of MA beneficiaries in 2016 by age and sex, gleaned from the Medicare 100% Research Identifiable Files, we estimated an age/sex adjustment reflecting the expected difference in state-specific fracture rates between Medicare FFS and MA due to demographics.

- Management/selection adjustment: We identified osteoporotic fracture events among a sample of MA beneficiaries in 2016 using Milliman's Consolidated Health Cost Guidelines™ Sources Database (CHSD). Osteoporotic fracture events were identified consistent with the methodology used for Medicare FFS beneficiaries (as described above in the Denominator Population and Identification of Beneficiaries With New Osteoporotic Fractures sections). We developed a healthcare management/selection adjustment factor by comparing age- and sex-adjusted fracture rates between Medicare FFS and MA beneficiaries. This factor reflects the estimated difference in fracture rates between Medicare FFS and MA beneficiaries resulting from factors such as the increased healthcare management among MA beneficiaries that is due to incentives for MA plans to engage in primary and secondary fracture prevention, as well as differences in the prevalence of chronic conditions. Due to insufficient MA data by state, this adjustment was calculated using national data and applied to all states.

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