Research Article

Medicare Payment for Orthopaedic Oncology Procedures Over the Past 20 Years

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ABSTRACT

Background: Medicare payment has been examined in a variety of medical and surgical specialties. This study examines Medicare payment in the subspecialty of orthopaedic oncology.

Methods: The Physician Fee Schedule Look-up Tool was used to obtain payment information from 2000 to 2020 for procedures related to orthopaedic oncology billed to Medicare.

Results: For the 38 included orthopaedic oncology procedures, inflation-adjusted Medicare payment decreased an average of 13.6% overall from 2000 to 2020. After adjusting for inflation, the payment for procedures related to spine and pelvis increased by 7.6%, procedures relating to limb salvage increased by 14.6%, procedures associated with the surgical management of complications decreased by 26.9%, and procedures relating to metastatic disease management decreased by 34.8%.

Conclusion: Medicare payment has declined by 13.6% from 2000 to 2020. This variation in Medicare payment represents a difference in valuation of these procedures by the Centers for Medicare and Medicaid Services and could be used to direct healthcare policy.

Medicare insures a large number of patients in the United States, covering those older than 65 years and others with qualifying health conditions.1,2 When Medicare was first created in 1965, the median life expectancy in the United States was 70.11 years; in comparison, the life expectancy in 2020 is 78.81 years.3 Accordingly, there has been a large increase in the population of Medicare patients in the United States, with the population covered by Medicare increasing from 13.5% of the US population in 2000 to nearly 18.1% in 2019.4 The increasing proportion of patients covered by Medicare, and the availability of Medicare payment data, provides an interesting area of economic analysis.

Physicians receive Medicare payment based on the specific medical service provided using a Current Procedural Terminology (CPT) code. Each CPT code is specific to each medical service and is reimbursed based on the valuation of the corresponding relative value units (RVUs). The RVUs for each CPT code are calculated and determined by the Relative Value Update Committee (RUC),

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| Procedure                                                                 | CPT Code | 2000 Reimbursement | 2020 Reimbursement | Percentage change 00–20 | CAGR | R sq |
|---------------------------------------------------------------------------|----------|--------------------|--------------------|--------------------------|-------|------|
| Open treatment of proximal humeral (surgical or anatomical neck) fracture, includes internal fixation, when performed, includes repair of tuberosity(s), when performed; with proximal humeral prosthetic replacement | 23616    | 2401               | 1307               | −44.4%                  | −3.2% | 0.84 |
| Arthroplasty, knee, condyle and plateau; medial AND lateral compartments with or without patella resurfacing (total knee arthroplasty) | 27447    | 2486               | 1430               | −41.3%                  | −2.9% | 0.92 |
| Prophylactic treatment (nailing, pinning, plating or wiring) with or without methylmethacrylate, femoral neck and proximal femur | 27187    | 1623               | 1052               | −38.9%                  | −2.3% | 0.81 |
| Open treatment of intertrochanteric, peritrochanteric, or subtrochanteric femoral fracture; with intramedullary implant, with or without interlocking screws and/or cerclage | 27245    | 2143               | 1298               | −38.1%                  | −2.6% | 0.88 |
| Arthroplasty, acetabular and proximal femoral prosthetic replacement (total hip arthroplasty), with or without autograft or allograft | 27130    | 2349               | 1432               | −37.8%                  | −2.6% | 0.85 |
| Repair, nonunion or malunion, femur, distal to head and neck; with iliac or other autogenous bone graft (includes obtaining graft) | 27472    | 2111               | 1335               | −35.5%                  | −2.4% | 0.80 |
| Prophylactic treatment (nailing, pinning, plating, or wiring) with or without methylmethacrylate, femur | 27495    | 1873               | 1192               | −35.1%                  | −2.4% | 0.79 |
| Open treatment of femoral supracondylar or transcondylar fracture without intercondylar extension, includes internal fixation, when performed | 27511    | 1624               | 1055               | −33.9%                  | −2.2% | 0.85 |
| Open treatment of femoral supracondylar or transcondylar fracture with intercondylar extension, includes internal fixation, when performed | 27513    | 1980               | 1311               | −32.5%                  | −2.1% | 0.89 |
| Prophylactic treatment (nailing, pinning, plating or wiring) with or without methylmethacrylate, tibia | 27745    | 1192               | 804                | −31.7%                  | −2.0% | 0.77 |
| Prophylactic treatment (nailing, pinning, plating or wiring), with or without methylmethacrylate, humeral shaft | 24498    | 1364               | 915                | −31.5%                  | −2.1% | 0.80 |
| Prophylactic treatment (nailing, pinning, plating or wiring) with or without methylmethacrylate; proximal humerus | 23491    | 1586               | 1073               | −30.9%                  | −2.0% | 0.82 |
| Hemiarthroplasty, hip, partial (eg, femoral stem prosthesis, bipolar arthroplasty) | 27125    | 1739               | 1196               | −29.7%                  | −1.9% | 0.72 |

(continued)
| Procedure                                                                 | CPT Code | 2000 Reimbursement | 2020 Reimbursement | Percentage change 00–20 | CAGR | R sq |
|--------------------------------------------------------------------------|----------|--------------------|--------------------|-------------------------|------|------|
| Removal of prosthesis, including total knee prosthesis, methylmethacrylate with or without insertion of spacer, knee | 27488    | 1823               | 1268               | −29.0%                  | −1.9%| 0.78 |
| Removal of hip prosthesis; complicated, including total hip prosthesis, methylmethacrylate with or without insertion of spacer | 27091    | 2406               | 1686               | −28.5%                  | −1.9%| 0.77 |
| Repair of nonunion or malunion, humerus; with iliac or other autograft (includes obtaining graft) | 24435    | 1598               | 1136               | −27.3%                  | −1.8%| 0.75 |
| Open treatment of humeral shaft fracture with plate/screws, with or without cerclage | 24515    | 1290               | 929                | −26.7%                  | −1.7%| 0.81 |
| Treatment of intertrochanteric, peritrochanteric, or subtrochanteric femoral fracture; with plate/screw type implant, with or without cerclage | 27244    | 1808               | 1299               | −26.6%                  | −1.7%| 0.72 |
| Muscle, myocutaneous, or fasciocutaneous flap; upper extremity | 15736    | 1775               | 1293               | −25.5%                  | −1.7%| 0.72 |
| Open treatment of femoral shaft fracture, with or without external fixation, with insertion of intramedullary implant, with or without cerclage and/or locking screws | 27506    | 1928               | 1413               | −25.2%                  | −1.6%| 0.83 |
| Repair of nonunion or malunion, tibia; with iliac or other autograft (includes obtaining graft) | 27724    | 1778               | 1330               | −23.4%                  | −1.5%| 0.80 |
| Muscle, myocutaneous, or fasciocutaneous flap; lower extremity | 15738    | 1793               | 1370               | −21.4%                  | −1.4%| 0.79 |
| Radical resection of tumor; talus or calcaneus | 27647    | 1323               | 1077               | −16.7%                  | −1.1%| 0.14 |
| Partial excision of posterior vertebral component (eg, spinous process, lamina or facet) for intrinsic bony lesion, single vertebral segment; thoracic | 22101    | 1092               | 915                | −15.4%                  | −0.9%| 0.42 |
| Partial excision of vertebral body, for intrinsic bony lesion, without decompression of spinal cord or nerve root(s), single vertebral segment; thoracic | 22112    | 1380               | 1170               | −12.4%                  | −0.9%| 0.34 |
| Partial excision of posterior vertebral component (eg, spinous process, lamina or facet) for intrinsic bony lesion, single vertebral segment; lumbar | 22102    | 989                | 864                | −11.3%                  | −0.7%| 0.80 |
| Partial excision of vertebral body, for intrinsic bony lesion, without decompression of spinal cord or nerve root(s), single vertebral segment; lumbar | 22114    | 1345               | 1170               | −10.1%                  | −0.7%| 0.52 |
| Radical resection of tumor, shaft or distal humerus | 24150    | 1603               | 1637               | 4.6%                    | 0.1% | 0.21 |

(continued)
| Procedure                                                                 | CPT Code | 2000 Reimbursement | 2020 Reimbursement | Percentage change 00–20 | CAGR | R sq |
|---------------------------------------------------------------------------|----------|--------------------|--------------------|-------------------------|------|------|
| Radical resection of tumor; fibula                                        | 27646    | 1537               | 1626               | 8.3%                    | 0.3% | 0.15 |
| Radical resection of tumor, radius or ulna                                | 25170    | 1376               | 1556               | 15.8%                   | 0.6% | 0.15 |
| Radical resection of tumor; tibia                                         | 27645    | 1650               | 1872               | 16.3%                   | 0.7% | 0.26 |
| Radical resection of tumor; ilium, including acetabulum, both pubic rami, | 27076    | 2356               | 2673               | 16.3%                   | 0.7% | 0.39 |
| Radial resection of tumor; ilium, including acetabulum, both pubic rami, | 27076    | 2356               | 2673               | 16.3%                   | 0.7% | 0.39 |
| or ischium and acetabulum                                                 |          |                    |                    |                         |      |      |
| Radical resection of tumor; wing of ilium, 1 pubic or ischial ramus or   | 27075    | 1882               | 2209               | 20.3%                   | 0.8% | 0.17 |
| symphysis pubis                                                           |          |                    |                    |                         |      |      |
| Radical resection of tumor; innominate bone, total                        | 27077    | 2503               | 2983               | 22.2%                   | 0.9% | 0.01 |
| Radical resection of tumor, femur or knee                                 | 27365    | 1801               | 2177               | 23.6%                   | 1.0% | 0.50 |
| Radical resection of tumor, proximal humerus                              | 23220    | 1656               | 2058               | 26.9%                   | 1.1% | 0.47 |
| Radical resection of tumor; scapula                                       | 23210    | 1388               | 1872               | 38.3%                   | 1.6% | 0.50 |
| Radical resection of tumor; ischial tuberosity and greater trochanter of | 27078    | 1475               | 2178               | 51.4%                   | 2.1% | 0.56 |
| femur                                                                     |          |                    |                    |                         |      |      |
| Median                                                                    |          |                     |                    |                         |      |      |
| Mean                                                                      |          |                     |                    |                         |      |      |

CPT = Current Procedural Terminology, CAGR = Compound Annual Growth Rate
The CPT codes and descriptions in this table were adapted from the orthopaedic surgery oncology fellowship ACGME case logs.17
which is a coalition of physicians from a variety of specialties. These payments are also intentionally adjusted by geographic region by Medicare.

Various subspecialties of orthopaedic surgery have reported downward trends in Medicare payment, such as total joint arthroplasty, trauma, hand and wrist, and arthroscopy. Decreasing Medicare payment is not unique to orthopaedic surgery, with decreases noted among many other specialties including emergency medicine, dermatology, urology, and neurosurgery. Current literature lacks an updated, long-term Medicare payment study in the field of musculoskeletal oncology. This study further defines the trends of inflation-adjusted Medicare payment in the field of musculoskeletal oncology.

Methods

The Medicare database used in this study is publicly available. Accordingly, this study did not require an institutional review board approval. Trends in Medicare payment have been examined for many subspecialties of orthopaedic surgery. Accordingly, the methods of this study were adapted from these previous studies to facilitate comparison between these studies and our study.

Table 2. Summary of Differences in Inflation-adjusted Medicare Payment Between Orthopaedic Oncology Procedures

| Orthopaedic Oncology Procedures       | No. of CPT Codes | Average Inflation-adjusted Medicare Payment 2000 | Average Inflation-adjusted Medicare Payment 2020 | Percentage Change |
|---------------------------------------|------------------|-----------------------------------------------|-----------------------------------------------|-------------------|
| Spine and pelvis                      | 8                | 1628                                          | 1770                                          | 7.6%              |
| Limb salvage                          | 8                | 1542                                          | 1734                                          | 14.6%             |
| Surgical management of complications  | 9                | 1834                                          | 1307                                          | −26.9%            |
| Metastatic management                 | 13               | 1859                                          | 1182                                          | −34.8%            |
| Overall                               | 38               | 1738                                          | 1452                                          | −13.6%            |

CPT = Current Procedural Terminology
Data Extraction
A list of procedures and their corresponding CPT codes representing orthopaedic oncology was obtained from the orthopaedic oncology fellowship Accreditation Council for Graduate Medical Education (ACGME) case log guidelines. These guidelines contain a categorized list of procedures pertaining to orthopaedic oncology. Only procedures common to 2000 and 2020 were included in this analysis. Accordingly, nine codes that did not exist in the year 2000 were excluded.

We obtained payment information from the CMS website using the Physician Fee Schedule Look-Up Tool for each CPT code in this study. Payment information was averaged for each geographic Medicare Administrative Contractor locality from 2000 to 2020 to obtain a yearly national average payment for each code. To adjust for inflation between 2000 and 2020, the national average payment information for each code was multiplied by the inflation multiplier for each year, which was calculated using the change in Consumer Price Index from the US Department of Labor, Bureau of Labor Statistics website. As such, inflation-adjusted amounts were adjusted to the worth of a US dollar as of January 1, 2021.

Statistical Analysis
Payment averages were compared by calculating the percentage change from 2000 to 2020 after adjusting for inflation. These results were analyzed using a two-tailed Student t-test comparison of means with alpha <0.05. We also conducted these same analyses for each category of musculoskeletal oncology procedures according to their designation in the ACGME case log. These

Table 3. Orthopaedic Oncology Procedures Related to Spine and Pelvis Inflation-adjusted Medicare Payment From 2000 to 2020

| Description                                                                 | CPT Code | 2000  | 2020  | Percentage change | CAGR     | R Sq  |
|-----------------------------------------------------------------------------|----------|-------|-------|-------------------|----------|-------|
| Partial excision of posterior vertebral component (eg, spinous process, lamina or facet) for intrinsic bony lesion, single vertebral segment; thoracic | 22101    | 1092  | 915   | −15.4%            | −0.9%    | 0.42  |
| Partial excision of vertebral body, for intrinsic bony lesion, without decompression of spinal cord or nerve root(s), single vertebral segment; thoracic | 22112    | 1380  | 1170  | −12.4%            | −0.9%    | 0.34  |
| Partial excision of posterior vertebral component (eg, spinous process, lamina or facet) for intrinsic bony lesion, single vertebral segment; lumbar | 22102    | 989   | 864   | −11.3%            | −0.7%    | 0.80  |
| Partial excision of vertebral body, for intrinsic bony lesion, without decompression of spinal cord or nerve root(s), single vertebral segment; lumbar | 22114    | 1345  | 1170  | −10.1%            | −0.7%    | 0.52  |
| Radical resection of tumor; ilium, including acetabulum, both pubic rami, or ischium and acetabulum | 27076    | 2356  | 2673  | 16.3%             | 0.7%     | 0.39  |
| Radical resection of tumor; wing of ilium, 1 pubic or ischial ramus or symphysis pubis | 27075    | 1882  | 2209  | 20.3%             | 0.8%     | 0.17  |
| Radical resection of tumor; innominate bone, total | 27077    | 2503  | 2983  | 22.2%             | 0.9%     | 0.01  |
| Radical resection of tumor; ischial tuberosity and greater trochanter of femur | 27078    | 1475  | 2178  | 51.4%             | 2.1%     | 0.56  |
| Median                                                                      | 1428     | 1674  |       | 3.1%              | 0.0%     | 0.41  |
| Mean                                                                        | 1628     | 1770  |       | 7.6%              | 0.2%     | 0.40  |

CPT = Current Procedural Terminology
The CPT codes and descriptions in this table were adapted from the orthopaedic surgery oncology fellowship ACGME case logs.
categories were spine and pelvis, limb salvage, surgical management of complications, and metastatic management. A compound annual growth rate was also included for each code, along with an r-squared value. The statistical analysis conducted in this study was calculated using Microsoft Excel for Office 365 (Microsoft).

Results

Our analysis included 38 CPT codes after excluding nine codes that did not exist in the year 2000 (Supplemental Table 1, http://links.lww.com/JG9/A227). The mean Medicare payment for the included 38 CPT codes after adjusting 2000 dollars to 2020 dollars for inflation decreased from $1,738 on average in 2000 to $1,452 on average in 2020 (13.6% decrease). The median inflation-adjusted payment of all codes from 2000 to 2020 decreased by 25.3%, and the payment change for each code from 2000 to 2020 ranged between a 51.4% increase and a 44.4% decrease (Table 1).

The categories of spine and pelvis and limb salvage experienced increases in inflation-adjusted Medicare payment of 7.6% and 14.6%, respectively. Inflation-adjusted Medicare payment decreased for surgical management of complications (−26.9%) and metastatic management (−34.8%) between the years of 2000 and 2020 (Figure 1 and Table 2).

Inflation-adjusted payment by Medicare for eight spine and pelvis procedures increased from $1,628 in 2000 to $1,770 in 2020 (7.6% increase). The largest decrease was seen for CPT code 22101 (partial excision of posterior vertebral component for intrinsic bony lesion, single vertebral segment; thoracic), which experienced a 15.4% decrease, whereas the largest increase in payment was seen for CPT code 27078 (radical resection of tumor; ischial tuberosity and greater trochanter of femur) at 51.4% (Table 3).

Inflation-adjusted Medicare payment for the eight limb salvage procedures increased from $1,542 in 2000 to $1,734 in 2020 (14.6% increase). All eight procedures in this category increased in inflation-adjusted payment by Medicare from 2000 to 2020. The smallest increase was seen for CPT code 27647 (radical resection of tumor; talus or calcaneus), which experienced a 4.6% increase, and the largest increase was seen for CPT code 23210 (radical resection of tumor; scapula) at 38.3% (Table 4).

Inflation-adjusted Medicare payment for surgical complications decreased from $1,834 in 2000 to $1,307 in 2020 (−26.9% decrease). The largest decrease was seen for CPT code 27472 (repair, nonunion or malunion, femur, distal to head and neck; with iliac or other autogenous bone graft, including obtaining graft), which experienced a −35.5% decrease, and the smallest decrease was seen for CPT code 15738 (muscle, myocutaneous, or fasciocutaneous flap; lower extremity) at −21.4% (Table 5).

Inflation-adjusted Medicare payment for metastatic management decreased from $1,859 in 2000 to $1,182

Table 4. Orthopaedic Oncology Procedures Related to Limb Salvage Inflation-adjusted Medicare Payment From 2000 to 2020

| Description                                    | CPT Code | 2000 | 2020 | Percentage change | CAGR | R Sq |
|------------------------------------------------|----------|------|------|-------------------|------|------|
| Radical resection of tumor; talus or calcaneus | 27647    | 1323 | 1077 | −16.7%            | −1.1%| 0.14 |
| Radical resection of tumor, shaft or distal humerus | 24150    | 1603 | 1637 | 4.6%              | 0.1% | 0.21 |
| Radical resection of tumor; fibula              | 27646    | 1537 | 1626 | 8.3%              | 0.3% | 0.15 |
| Radical resection of tumor, radius or ulna      | 25170    | 1576 | 1556 | 15.8%             | 0.6% | 0.15 |
| Radical resection of tumor; tibia               | 27645    | 1560 | 1872 | 16.3%             | 0.7% | 0.26 |
| Radical resection of tumor, femur or knee       | 27385    | 1801 | 2177 | 23.6%             | 1.0% | 0.50 |
| Radical resection of tumor, proximal humerus    | 23220    | 1656 | 2058 | 26.9%             | 1.1% | 0.47 |
| Radical resection of tumor; scapula             | 23210    | 1388 | 1872 | 38.3%             | 1.6% | 0.50 |
| Median                                          | 1570     | 1754 | 16.1%| 0.7%              | 0.24 |
| Mean                                            | 1542     | 1734 | 14.6%| 0.5%              | 0.30 |

CPT = Current Procedural Terminology
The CPT codes and descriptions in this table were adapted from the orthopaedic surgery oncology fellowship ACGME case logs.17
in 2020 (−34.8% decrease). The largest decrease was seen for CPT code 23616 (open treatment of proximal humeral fracture), which experienced a −41.3% decrease, and the smallest decrease was seen for CPT code 27244 (treatment of intertrochanteric, peritrochanteric, or subtrochanteric femoral fracture; with plate/screw type implant, with or without cerclage) at −26.6% (Table 6).

**Discussion**

In musculoskeletal oncology, inflation-adjusted Medicare payment has decreased between the years of 2000 to 2020, with a 13.6% mean decrease overall, with a maximum decrease in payment of 44.4% for open treatment of the proximal humerus and a maximum increase in payment of 51.4% for the radical resection of tumor from the ischial tuberosity and greater trochanter of the femur. The orthopaedic oncology procedures associated with increases in inflation-adjusted Medicare payment are spine and pelvis and limb salvage, whereas the procedures with the largest decrease in payment were related to surgical complications and metastatic management. Orthopaedic oncology has experienced a similar decrease in comparison with other subspecialties of orthopaedic surgery. For example, Medicare payment after adjusting for inflation decreased 39% for knee arthroplasty and hip

| Description                                                                 | CPT code | 2000 | 2020 | Percentage change | CAGR | R Sq |
|----------------------------------------------------------------------------|----------|------|------|-------------------|------|------|
| Repair, nonunion or malunion, femur, distal to head and neck; with iliac or other autogenous bone graft (includes obtaining graft) | 27472    | 2111 | 1335 | −35.5%            | −2.4%| 0.80 |
| Removal of prosthesis, including total knee prosthesis, methylmethacrylate with or without insertion of spacer, knee | 27488    | 1823 | 1268 | −29.0%            | −1.9%| 0.78 |
| Removal of hip prosthesis; complicated, including total hip prosthesis, methylmethacrylate with or without insertion of spacer | 27091    | 2406 | 1686 | −28.5%            | −1.9%| 0.77 |
| Repair of nonunion or malunion, humerus; with iliac or other autograft (includes obtaining graft) | 24435    | 1598 | 1136 | −27.3%            | −1.8%| 0.75 |
| Open treatment of humeral shaft fracture with plate/screws, with or without cerclage | 24515    | 1290 | 929  | −26.7%            | −1.7%| 0.81 |
| Muscle, myocutaneous, or fasciocutaneous flap; upper extremity               | 15736    | 1775 | 1293 | −25.5%            | −1.7%| 0.72 |
| Open treatment of femoral shaft fracture, with or without external fixation, with insertion of intramedullary implant, with or without cerclage and/or locking screws | 27506    | 1928 | 1413 | −25.2%            | −1.6%| 0.83 |
| Repair of nonunion or malunion, tibia; with iliac or other autograft (includes obtaining graft) | 27724    | 1778 | 1330 | −23.4%            | −1.5%| 0.80 |
| Muscle, myocutaneous, or fasciocutaneous flap; lower extremity               | 15738    | 1793 | 1370 | −21.4%            | −1.4%| 0.79 |
| Median                                                                      |          | 1793 | 1330 | −26.7%            | −1.7%| 0.79 |
| Mean                                                                        |          | 1834 | 1307 | −26.9%            | −1.8%| 0.78 |

CPT = Current Procedural Terminology

The CPT codes and descriptions in this table were adapted from the orthopaedic surgery oncology fellowship ACGME case logs.17
Table 6. Orthopaedic Oncology Procedures Related to Metastatic Management Inflation-adjusted Medicare Payment From 2000 to 2020

| Description                                                                 | CPT code  | 2000  | 2020  | Percentage change | CAGR  | R Sq  |
|----------------------------------------------------------------------------|-----------|-------|-------|-------------------|-------|-------|
| Open treatment of proximal humeral (surgical or anatomical neck) fracture, includes internal fixation, when performed, includes repair of tuberosity(s), when performed; with proximal humeral prosthetic replacement | 23616     | 2401  | 1307  | −44.4%            | −3.2% | 0.84  |
| Arthroplasty, knee, condyle and plateau; medial AND lateral compartments with or without patella resurfacing (total knee arthroplasty) | 27447     | 2486  | 1430  | −41.3%            | −2.9% | 0.92  |
| Prophylactic treatment (nailing, pinning, plating or wiring) with or without methylmethacrylate, femoral neck and proximal femur | 27187     | 1623  | 1052  | −38.9%            | −2.3% | 0.81  |
| Open treatment of intertrochanteric, peritrochanteric, or subtrochanteric femoral fracture; with intramedullary implant, with or without interlocking screws and/or cerclage | 27245     | 2143  | 1298  | −38.1%            | −2.6% | 0.88  |
| Arthroplasty, acetabular and proximal femoral prosthetic replacement (total hip arthroplasty), with or without autograft or allograft | 27130     | 2349  | 1432  | −37.8%            | −2.6% | 0.85  |
| Prophylactic treatment (nailing, pinning, plating, or wiring) with or without methylmethacrylate, femur | 27495     | 1873  | 1192  | −35.1%            | −2.4% | 0.79  |
| Open treatment of femoral supracondylar or transcondylar fracture without intercondylar extension, includes internal fixation, when performed | 27511     | 1624  | 1055  | −33.9%            | −2.2% | 0.85  |
| Open treatment of femoral supracondylar or transcondylar fracture with intercondylar extension, includes internal fixation, when performed | 27513     | 1980  | 1311  | −32.5%            | −2.1% | 0.89  |
| Prophylactic treatment (nailing, pinning, plating or wiring) with or without methylmethacrylate, tibia | 27745     | 1192  | 804   | −31.7%            | −2.0% | 0.77  |
| Prophylactic treatment (nailing, pinning, plating or wiring), with or without methylmethacrylate, humeral shaft | 24498     | 1364  | 915   | −31.5%            | −2.1% | 0.80  |
| Prophylactic treatment (nailing, pinning, plating or wiring) with or without methylmethacrylate; proximal humerus | 23491     | 1586  | 1073  | −30.9%            | −2.0% | 0.82  |
| Hemiarthroplasty, hip, partial (eg, femoral stem prosthesis, bipolar arthroplasty) | 27125     | 1739  | 1196  | −29.7%            | −1.9% | 0.72  |
| Treatment of intertrochanteric, peritrochanteric, or subtrochanteric femoral fracture; with plate/screw type implant, with or without cerclage | 27244     | 1808  | 1299  | −26.6%            | −1.7% | 0.72  |
| Median                        |           | 1808  | 1196  | −33.9%            | −2.2% | 0.82  |
| Mean                          |           | 1859  | 1182  | −34.8%            | −2.3% | 0.82  |

CPT = Current Procedural Terminology
The CPT codes and descriptions in this table were adapted from the orthopaedic surgery oncology fellowship ACGME case logs.17
arthroplasty from 2000 to 2019, on average.\textsuperscript{7} Inflation-adjusted Medicare payment decreased for shoulder and elbow by 27% from 2002 to 2018.\textsuperscript{20} Inflation-adjusted Medicare payment for arthroscopy procedures decreased from 2000 to 2019 by 30% for commonly performed arthroscopy procedures.\textsuperscript{15}

Our analysis also revealed that categories of orthopaedic oncology surgery are affected to different degrees by decreases in Medicare payment. For example, spine, pelvis, and limb salvage procedures increased in payment by Medicare from 2000 to 2020, whereas surgical complication management and metastatic management decreased in payment. It has been reported that the RVUs may not accurately reflect surgeon work, and these findings can help contextualize and quantify payments for comparison.\textsuperscript{21}

Medicare payment is markedly less than commercial payors, but this difference varies by procedure. A study examining payment trends for shoulder arthroscopy found that payment from private payors was more than double of Medicare payment, while private payment for shoulder arthroscopy: capsulorrhaphy was only 16% more than Medicare payment.\textsuperscript{22} Another study found that both commercial and Medicare payment for an orthopaedic procedure has decreased from 2010 to 2018, with payments by Medicare decreasing 1.5 times faster than commercial payments, on average.\textsuperscript{23} Payment trends of large, commercial payors warrants future analysis to further define these trends.

Healthcare policy changes over the past two decades have likely affected the payment trends seen in our study, for example, the Balanced Budget Act of 1997 and the Medicare Access and CHIP Reauthorization Act of 2015. Although these policies have likely influenced the payment trends seen in our study, annual adjustments to CPT code pricing are also directly responsible for the changes seen in our study. CPT code valuations are updated on an annual basis by the RUC, a committee of volunteer physicians from different specialties.\textsuperscript{24} This committee currently includes one orthopaedic surgeon.\textsuperscript{24} To determine valuations and payment changes, RUC physicians adjust the valuation of CPT codes by adjusting the associated RVUs. These changes can occur through modification of one, two, or three RVU components of differing weights, consisting of work RVU, practice expense RVU, and malpractice RVU. Payment for medical services is also affected by geographic adjustments named the work geographic pricing cost index (GPCI), practice expense GPCI, and malpractice GPCI. RVUs and GPCIs are multiplied together and assigned weights. Subsequently, the resulting value is multiplied by the corresponding year’s conversion factor to determine physician payment. Notably, the conversion factor affects all CPT codes in medicine equally and has decreased slightly throughout 2000 to 2020, being $36.61 in 2000 and $36.09 in 2020.\textsuperscript{25}

A few limitations should be mentioned for this study. The codes included in our study do not represent all the possible procedures and services performed by orthopaedic oncologists. In addition, this study uses data from a single payor, and as such, the trends observed in our study may not represent payment by third party payors. Additional study is needed to elucidate trends in payment amount from third party payors from 2000 to 2020.

**Conclusion**

Medicare payment for orthopaedic oncology has declined 13.6% from 2000 to 2020. Although the payment for spine and pelvic procedures increased by 7.6%, payment for procedures relating to metastatic disease management decreased by 34.8%. This variation in Medicare payment represents a difference in valuation of these procedures by the CMS and could be used to direct healthcare policy. An understanding of these trends is essential because hospitals, physicians, and policy makers can use this information to address declining payment while also continuing to ensure equitable access to care for Medicare patients.

**References**

1. History | CMS. https://www.cms.gov/about-cms/agency-information/history?redirect=history%27. Accessed April 15, 2022.
2. Medicare Program - General Information | CMS. https://www.cms.gov/Medicare/Medicare-GenInfo. Accessed April 15, 2022.
3. United States: Life expectancy 1860-2020 | Statista. https://www.statista.com/statistics/1040079/life-expectancy-united-states-all-time/. Accessed April 15, 2022.
4. Medicare covered share U.S. 1990-2019 | Statista. https://www.statista.com/statistics/200962/percentage-of-americans-covered-by-medicare/. Accessed April 15, 2022.
5. Gao YN: Committee representation and Medicare reimbursements—an examination of the resource-based relative value scale. *Health Serv Res* 2018;53:4353-4370. Accessed April 15, 2022.
6. Thomburg DA, Gupta N, Chow N: An analysis of procedural Medicare reimbursement rates in hand surgery: 2000 to 2019. *Hand (N Y)* 2021. https://journals.sagepub.com/doi/10.1177/155894421980877?url_ver=Z39.88-2003&rfr_id=ori:rid:crossref.org&rfr_dat=cr_pub%20med. Accessed April 15, 2022.
7. Haglin JM, Arthur JR, Deckey DG, Makovicka JL, Pollock JR, Spanghel MJ: Temporal analysis of Medicare physician
reimbursement and procedural volume for all hip and knee arthroplasty procedures billed to Medicare Part B from 2000 to 2019. J Arthroplasty 2021;36:S121-S127.

8. Haglin JM, Lott A, Kugelman DN, Konda SR, Egol KA: Declining Medicare reimbursement in orthopaedic trauma surgery: 2000-2020. J Orthop Trauma 2021;35:79-85.

9. Smith JF, Moore ML, Pollock JR, et al: National and geographic trends in Medicare reimbursement rates for orthopedic shoulder and upper extremity surgery from 2000 to 2020. J Shoulder Elbow Surg 2022;31:860-867.

10. Eltorai AEM, Durand WM, Haglin JM, Rubin LE, Weiss A-PC, Daniels AH: Trends in Medicare reimbursement for orthopedic procedures: 2000 to 2016. Orthopedics 2018;41:95-102.

11. Ginsberg Z, Pollock JR, Rappaport DE: Decrease in Medicare reimbursement for single-laceration repairs in the emergency department. Acad Emerg Med 2021;28:582-585.

12. Harrington MT, Pollock JR, Haglin JM, Richter KR, Patel NP: An analysis of Medicare reimbursement for neurosurgeon office visits: 2010 compared to 2016. Neurosurgery 2021;89:E42-E48.

13. Pollock JR, Bollig TR, Haglin JM, Sandefur BJ, Rappaport DE, Lindor RA: Medicare reimbursement to physicians decreased for common emergency medicine services from 2000 to 2020. Ann Emerg Med 2020;76:615-620.

14. Haglin JM, Eltorai AEM, Richter KR, Jogerst K, Daniels AH: Medicare reimbursement for General surgery procedures: 2000 to 2018. Ann Surg 2019;271:17-22.

15. Moore ML, Pollock JR, Haglin JM, et al: A comprehensive analysis of Medicare reimbursement to physicians for common arthroscopy procedures: Adjusted reimbursement has fallen nearly 30% from 2000 to 2019. Arthroscopy 2020;37:1632-1638.

16. Pollock JR, Chen JY, Dorius DA, et al: Decreasing physician Medicare reimbursement for dermatology services. J Am Acad Dermatol 2022;86:1154-1156.

17. 270_caselogguidelines_musculoskeletaloncology.pdf. https://www.acgme.org/globalassets/pfassets/programresources/270_caselogguidelines_musculoskeletaloncology.pdf. Accessed April 15, 2022.

18. Physician fee schedule search. https://www.cms.gov/apps/physician-fee-schedule/search/search-criteria.aspx. Accessed April 15, 2022.

19. CPI home: U.S. Bureau of Labor Statistics. https://www.bls.gov/cpi/. Accessed April 15, 2022.

20. Malik AT, Kopechek KJ, Bishop JY, Cvetanovich GL, Khan SN, Neviser AS: Declining trends in Medicare physician reimbursements for shoulder surgery from 2002 to 2018. J Shoulder Elbow Surg 2020;29:e451-e461.

21. Isaacson MJ, Bunn KJ, Noble PC, Ismaily SK, Incavo SJ: Quantifying and Predicting surgeon work input in Primary vs revision total hip arthroplasty. J Arthroplasty 2016;31:1188-1193.

22. Dunn L: 11 Statistics and Facts About Orthopedics and Orthopedic Practices. https://www.beckersspine.com/lists-and-statistics/item/739-11-statistics-and-facts-about-orthopedics-and-orthopedic-practices. Accessed April 15, 2022.

23. Wang KY, Margalit A, Thakkar SC, et al: Reimbursement for orthopaedic surgeries in commercial and public payors: A race to the bottom. J Am Acad Orthop Surg 2021;29:e1232-e1238.

24. Composition of the RVS Update Committee (RUC). https://www.ama-assn.org/about/rvs-update-committee-ruc/composition-rvs-update-committee-ruc. Accessed April 15, 2022.

25. History of Medicare Conversion Factors. at https://www.ama-assn.org/system/files/2021-01/cf-history.pdf American Medical Association. Accessed April 15, 2022.