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Reassessment of Relative Value in Shoulder and Elbow Surgery: Do Payment and Relative Value Units Reflect Reality?

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Background: Many U.S. health care institutions have adopted compensation models based on work relative value units (wRVUs) to standardize payments and incentivize providers. A major determinant of payment and wRVU assignments is operative time. We sought to determine whether differences in estimated operative times between the Centers for Medicare & Medicaid Services (CMS) and the National Surgical Quality Improvement Program (NSQIP) contribute to payment and wRVU misvaluation for the most common shoulder/elbow procedures.

Methods: We collected data on wRVUs, payments, and operative times from CMS for 29 types of isolated arthroscopic and open shoulder/elbow procedures. Using regression analysis, we compared relationships between these variables, in addition to median operative times reported by NSQIP (2013–2016). We then determined the relative valuation of each procedure based on operative time.

Results: Seventy-nine percent of CMS operative time were longer than NSQIP time (R^2 = 0.58), including, but not limited to, shoulder arthroplasty and arthroscopic shoulder surgery. The correlation between payments and operative times was stronger between CMS data (R^2 = 0.61) than NSQIP data (R^2 = 0.43). Similarly, the correlation between wRVUs and operative times was stronger when using CMS data (R^2 = 0.87) than NSQIP data (R^2 = 0.69). Nearly all arthroscopic shoulder procedures (aside from synovectomy, debridement, and decompression) were highly valued according to both datasets. Per NSQIP, compensation for revision total shoulder arthroplasty ($10.14/min; 0.26 wRVU/min) was higher than that for primary cases ($9.85, 0.23 wRVU/min) and nearly twice the CMS rate for revision cases ($5.84/min; 0.13 wRVU/min).

Conclusions: CMS may overestimate operative times compared to actual operative times as recorded by NSQIP. Shorter operative times may render certain procedures more highly valued than others. Case examples show that this can potentially affect patient care and incentivize higher compensating procedures per operative time when less-involved, shorter operations have similar patient-reported outcomes.

Keywords: *Payment, Relative value unit, Shoulder arthroplasty, Shoulder arthroscopy, Operative time*

In the early 2000s, the work relative value unit (wRVU)-based compensation model was adopted widely across the United States to measure productivity.[1] Both public (Centers for Medicare & Medicaid Services [CMS], the national health insurance program of the United States) and private insurers use wRVUs to calculate standardized payment rates according to Current Procedural Terminology (CPT)

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codes. In a fee-for-service model, the wRVU metric is intended to reflect total physician work, including time and relative complexity of a procedure, as well as practice expenses, including those for staff, supplies, and other costs associated with operating an office or a surgical center, typically for a 90-day period after surgery. Because many physicians' employment contracts and hospitals' revenues are based on wRVU generation, a thorough understanding of wRVUs and payments is critical to maintain a fiscally responsible practice.

There have been calls for reform of the wRVU model. First, wRVUs may correlate poorly with perioperative workload, surgical complexity, and surgical time. This has been shown in orthopedic procedures, including minimally invasive sacroiliac joint arthrodesis;[2] extended posterior vertebral instrumentation;[3] and primary versus revision total knee arthroplasty (TKA),[4] total hip arthroplasty (THA),[5] and total ankle arthroplasty.[6] Findings were similar for common general surgery procedures[7] and acute care surgery.[8] Second, CMS may use outdated and/or inaccurate surgical time data, which is problematic because a major component of wRVU valuation is based on surgical time. CMS estimates surgical time from surveys conducted by specialty societies for the American Medical Association. These surveys may have low sample sizes and response rates and may not correlate well with "real world" surgical times recorded in other databases, such as the National Surgical Quality Improvement Program (NSQIP). Surgical time inaccuracy may cause higher wRVU valuation and payment for certain procedures and lower valuation for others, which can lead to systematic inequalities in payment and compensation.[9]

Our objective was to determine whether differences in estimated surgical times between CMS and NSQIP may contribute to payment and wRVU misvaluation for the most common surgical shoulder and elbow procedures. First, we determined how well CMS payment and wRVU rates correlate to CMS surgical times. We then compared these same rates against NSQIP actual surgical times. With these data, we determined which individual procedure has higher or lower valuations on the basis of surgical time inaccuracy. We used these findings to show how certain surgery may be better incentivized even if not supported by current evidence. From these analyses, we concluded that careful payment and wRVU adjustments can better align surgical incentives with appropriate surgical indications to optimize patient outcomes.

METHODS

This study was exempt from Institutional Review Board review. The wRVUs[10] and allowed payments[11] were collected from CMS data for all isolated, elective open and arthroscopic shoulder and elbow procedures (by CPT code). These procedures were done in a facility, non-office setting and only included procedures with individual volumes greater than 1,000.[11] This yielded 29 CPT codes. For these 29 procedures, we collected surgical/operative times (defined as skin incision to closure) and perioperative times (which includes pre-evaluation, positioning, draping, scrubbing, skin incision to closure, and post-service times)[12] for these procedures. We excluded fracture treatment codes typically associated with orthopedic trauma. Median surgical times (variable, "optime") were also collected from the NSQIP database for 2013 through 2016. Surgical time was measured from skin incision to closure in both CMS and NSQIP data. Relationships between these variables were explored with linear regression analysis. The relative valuation for each procedure was determined by comparing actual versus calculated payment based on the regression equations. All payments and surgical times were evaluated independently from patient factors, such as comorbidities and associated CPT modifiers (e.g., for case complexity).

Given the recent interest in primary versus revision arthroplasty reimbursement, as reported in the fields of knee,[13] hip,[5] and ankle[6] arthroplasty, we included a subgroup analysis for payment and wRVU rates for primary versus revision total shoulder arthroplasty (TSA). NSQIP entries with surgical times shorter than 30 minutes or longer than 480 minutes were excluded from the analysis; this represented 0.73% of primary cases and 0.30% of revision cases. These cutoffs were designed to eliminate improbable surgical times and have been used in similar studies.[5,13] Student *t*-tests and analysis of variance were used to compare median NSQIP compensation rates and surgical times for TSA ($\alpha = 0.05$). Statistical analysis could not be done with CMS data because individual patient surgical times and payment entries under each CPT code were not published.

RESULTS

wRVUs, payment amounts, and surgical times for these 29 procedures are shown separately in Supplementary Tables 1 and 2. There was a wide discrepancy between CMS and NSQIP surgical times ($R^2 = 0.58$), with 79% (23 procedures) of CMS times being longer than NSQIP times.

Procedures with wide discrepancies included, but were not limited to, shoulder arthroplasty and arthroscopic shoulder surgery. Payments were correlated more strongly with CMS surgical times (R^2 = 0.61) than with NSQIP surgical times (R^2 = 0.43) (Fig. 1). Similarly, wRVUs were more strongly correlated with CMS surgical times (R^2 = 0.87) than with NSQIP surgical times (R^2 = 0.69) (Table 1). The deviation of each procedure from the regression line in Fig. 1 is quantified to measure a procedure's value compared against all 29 procedures analyzed (Fig. 2). Nearly all arthroscopic shoulder procedures except synovectomy, debridement, and subacromial decompression were highly valued according to both CMS and NSQIP surgical times.

For the subgroup analysis comparing primary versus revision TSA, surgical times were shorter for primary surgery in the CMS data (140 minutes vs. 205 minutes) and the NSQIP data (103 ± 43 minutes vs. 119 ± 62 minutes, $p < 0.001$) (Table 2). When calculating payment per minute, primary procedures were compensated 24% more per minute ($7.24 vs. $5.84) according to CMS surgical times and 6% less per minute according to NSQIP surgical times ($9.85 vs. $10.14). wRVUs per minute showed similar trends of payment per minute for CMS data (0.16/min wRVUs vs. 0.13/min wRVUs) and NSQIP data (0.23/min wRVUs vs. 0.26/min wRVUs, $p < 0.001$). Notably, compensation for revision TSA was nearly twice the amount per NSQIP surgical time ($10.14/min; 0.26 RVU/min) versus CMS surgical time ($5.84/min; 0.13 RVU/min).

DISCUSSION

For the most common surgical shoulder and elbow procedures, there is a wide difference between CMS and NSQIP surgical times, rendering certain procedures potentially misvalued. Seventy-nine percent of NSQIP surgical times were shorter than those used by CMS, including but not limited to times for shoulder arthroplasty and arthroscopic shoulder surgery. The weakest correlations were between CMS and NSQIP surgical times, as well as between payments and NSQIP surgical times. CMS pay-

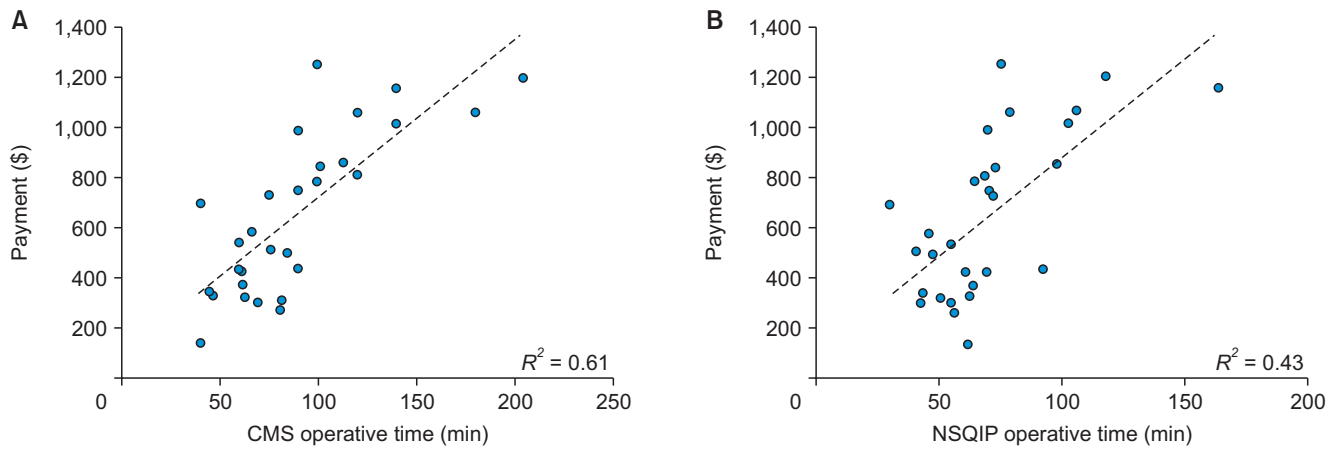

Fig. 1. Payment versus surgical time according to Centers for Medicare & Medicaid Services (CMS) data (A) and National Surgical Quality Improvement Program (NSQIP) data (B) for 29 shoulder and elbow procedures. Data points above the regression lines (higher payment) represent procedures that are compensated at a higher amount per surgical time compared with the other procedures analyzed. Conversely, data points below the regression lines are compensated at a lower amount.

Table 1. Correlations (R^2 Values) between Payments, wRVUs, and Surgical Times for 29 Shoulder and Elbow Procedures Using CMS and NSQIP Data

Variable	CMS surgical time	CMS perioperative time	NSQIP surgical time	wRVU
Payment	0.61	0.64	0.43	0.71
wRVU	0.87	0.91	0.69	NA
CMS surgical time	NA	NA	0.58	NA

The table is presented as a matrix. Each value represents the coefficient of determination (R^2) of the intersecting variables.
wRVU: work relative value unit, CMS: Centers for Medicare & Medicaid Services, NSQIP: National Surgical Quality Improvement Program, NA: not available.

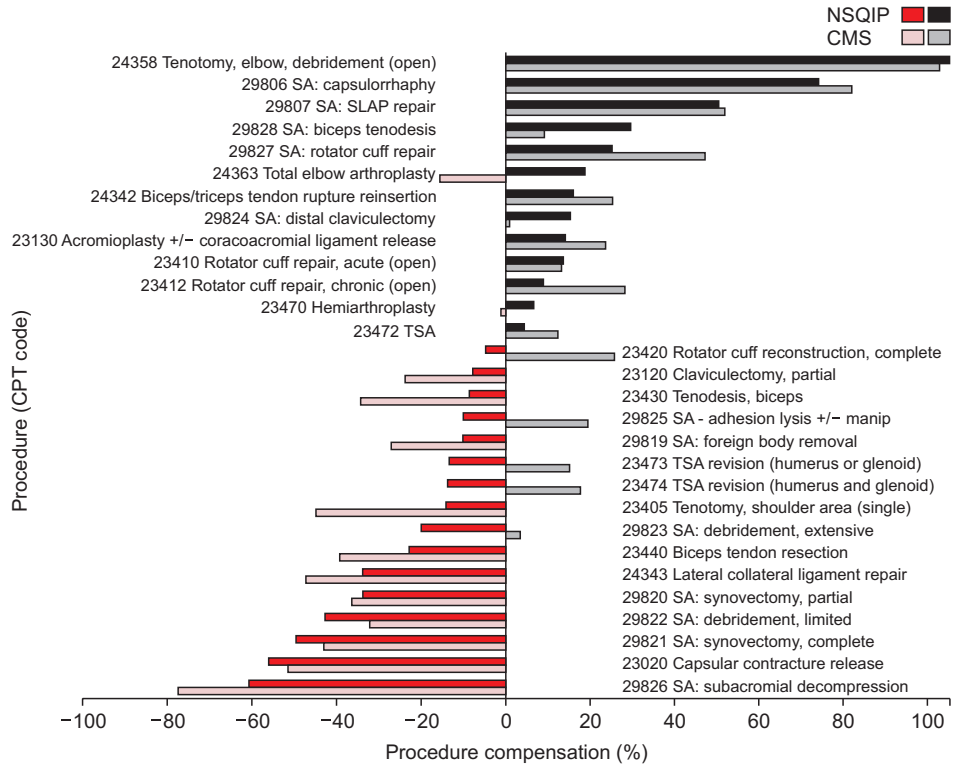

Fig. 2. Calculated procedure compensation based on National Surgical Quality Improvement Program (NSQIP) and Centers for Medicare & Medicaid Services (CMS) surgical time data. Codes to the right of the Y-axis are more highly compensated, whereas those to the left are compensated less. The percentages show how much each procedure deviates from the regression lines shown in Fig. 1. For example, total shoulder arthroplasty (TSA) revision (humerus and glenoid components, code 23474) has an associated payment of $1,197, which is 13.6% less than that calculated by using CMS surgical time ($1,385; Fig. 1A) and 17.6% more than that calculated by using NSQIP surgical time ($1,017; Fig. 1B). For this code, there is a large disparity between NSQIP and CMS surgical times (205 vs. 119 minutes). SA: should arthroscopy, SLAP: superior labrum anterior and posterior, CPT: Current Procedural Terminology.

Table 2. Mean (Standard Deviation*) Payments and wRVUs per Minute of Surgical Time for Primary and Revision Total Shoulder Arthroplasty According to CMS and NSQIP Data

Parameter	CMS		NSQIP		
	Primary	Revision	Primary	Revision	*p*-value†
Surgical time (min)	140	205	103 ± 43	119 ± 62	< 0.001
Payment/min ($)	7.24	5.84	9.85	10.14	0.03
wRVU/min	0.16	0.13	0.23 ± 0.09	0.26 ± 0.12	< 0.001

wRVU: work relative value unit, CMS: Centers for Medicare & Medicaid Services, NSQIP: National Surgical Quality Improvement Program.
*Standard deviations are unavailable in CMS data. †For primary vs. revision NSQIP groups.

ments favor primary shoulder TSA, whereas NSQIP data show that revision TSA cases are compensated at a higher rate. These data contrast with NSQIP findings in TKA[13] and THA,[5] in which primary cases were reimbursed at higher amounts than were revision cases. A mutual understanding of these findings amongst payers, providers, and healthcare systems is critically important to align surgical incentives with optimized patient outcomes.

The large difference in surgical times between these 2 data sources raises concern that the times used by CMS to calculate payments are inaccurate. This has been shown by a CMS pilot project that addresses misvalued surgical services in multiple specialties.[9] This discrepancy suggests that surgeons and hospitals/surgical centers may be improving their efficiency, perhaps through the introduction of technologies and surgical techniques that shorten surgi-

cal times. This reduction in operating time does not necessarily warrant decreased compensation of procedures, as additional training and expertise as well as personnel are often required to achieve higher efficiency, justifying higher wRVU and payment rates. The wide range of surgical times also shows a high degree of case complexity. For example, the interquartile range for an arthroscopic rotator cuff repair is 58 to 107 minutes (Supplementary Table 1), yet minor and massive tears are reimbursed at the same rate, with the exception of complexity modifiers. This highlights the need for further subcoding of certain procedures.

The findings shown in Fig. 2 also may help explain certain practice patterns. For example, an arthroscopic superior labrum anterior and posterior (SLAP) repair (CPT code 29807) is a highly valued procedure with the third-highest payment rate among all procedures analyzed. A review of data from the American Board of Orthopaedic Surgery[14] showed that orthopedic surgery residency graduates report rates of SLAP repairs that are 3 times higher than the published incidence of SLAP tears, suggesting that these operations may be done when not clinically indicated. Several studies have suggested that patients with SLAP tears who are older than 40 years may be better treated with arthroscopic biceps tenodesis[15-17] (CPT code 29828). Arthroscopic SLAP repairs generate 40% and 130% higher payments (NSQIP payment/minute) compared with arthroscopic and open biceps tenodesis, respectively (Supplementary Table 2). This may inadvertently misalign clinical and financial interests, which has the potential to affect patient care.

In another example, lateral epicondyle debridement (CPT code 24358) has both the highest payment/min (Supplementary Table 2) and valuation (Fig. 2) of all 29 procedures analyzed. While most presentations of epicondylitis resolve with conservative treatment, debridement may be offered for persistent cases. However, the efficacy of this surgery has been questioned. A study comparing debridement and repair versus sham treatment (muscle belly exposure only) showed no difference between treatment groups.[18] In a letter to the editor, it was noted that the sham procedure was likely a lateral denervation treatment.[4] Of note, coding as a denervation procedure (CPT 64708) yields far less payment per operative time at a valuation of –25% compared to +105% for epicondyle debridement per CMS estimates (Supplementary Table 1).

Our analysis of primary versus revision TSA shows that payments for revision TSA are higher than the reported payments for TKA and THA. In fact, the number of wRVUs per minute for revision TSA is the same as that for primary TKA and THA (all 0.26 wRVU/min) (Table 3).[5,13] This is explained in part by the shorter surgical times for revision shoulder surgery than those for revision TKA and THA. The value of revision TSA increases further when considering that the average hospital stay after revision TSA is shorter than that after TKA or THA.[19,20] These findings indicate that revision TKA and THA may be undervalued. Implant technology, such as humeral stems that permit stem retention during revision from anatomic to reverse TSA, may further widen this discrepancy and make previous surgical times less applicable to current cases. Surgical times varied widely for revision TSA, TKA, and THA (standard deviation > 1 hour). Because revisions require various levels of surgical demand (e.g., component failure for subsidence, infection, and bone loss), it may be important to consider revision subcodes to quantify the extent of the procedure more accurately, allowing appropriate compensation for surgical time, effort, and risk.

We found high valuation for the majority of shoulder arthroscopy procedures. In certain procedures, such as

Table 3. Surgical Times (Standard Deviation), wRVUs per Minute of Surgical Time, and Duration of Hospital Stays[17,18] for Primary versus Revision Shoulder, Knee,[4] and Hip[5] Arthroplasty

Parameter	Shoulder arthroplasty		Knee arthroplasty[4]		Hip arthroplasty[5]		*p*-value*	
	Primary	Revision	Primary	Revision	Primary	Revision	Primary	Revision
Surgical time (min)†	103 ± 43‡	119 ± 62‡	94 ± 36§	149 ± 61§	94 ± 38§	152 ± 75§	< 0.001	< 0.001
wRVU/min*	0.23 ± 0.1	0.26 ± 0.1	0.26 ± 0.1	0.22 ± 0.1	0.26 ± 0.1	0.25 ± 0.1	< 0.001	< 0.001
Hospital stay (day)‖	2.5	3.1	4.8	5.6	4.7	6.3	NA	NA

Values are presented as mean ± standard deviation.
wRVU: work relative value unit, NA: not available, NSQIP: National Surgical Quality Improvement Program.
*From analysis of variance testing between shoulder, knee, and hip arthroplasty across all primary and revision groups. †All surgical times and wRVU rates are based on NSQIP data. ‡Median surgical time was used because of abnormal distribution of NSQIP data and smaller group size compared with those in the referenced knee and hip studies. §Mean surgical time. ‖Standard deviations were unavailable for length of hospital stay.

arthroscopic SLAP repair, higher payment may inadvertently guide practice patterns away from those supported by the available clinical evidence (i.e., biceps tenodesis in place of SLAP repairs). In other procedures, such as arthroscopic rotator cuff repair, higher payment may be warranted to incentivize surgeons to offer arthroscopic technique, which is patient-preferred and leads to fewer complications, lower rates of readmission, decreased pain, and better function than open repair.[21-25]

There are limitations to this study. The mean allowed payments we used (Supplementary Table 1) may vary regionally and by practice; however, the relative differences between procedures would likely remain. wRVUs include physician work in the clinic during the postoperative global care period, which is typically 90 days. Although this factor should not vary enough to change our results, as most shoulder procedures require extended postoperative immobilization followed by gradual therapy, our lack of postoperative care information is a limitation. We analyzed CPT codes in isolation when, in practice, multiple codes can be billed in a single case. However, decreasing reimbursement for each additional code per Medicare's multiple code rule lessens this effect. A true comparison of surgical times between these databases is challenging because the values are averages and do not account for surgical setting. Streamlined ambulatory surgical centers may have shorter surgical times than do county hospitals. Further, there is no way to determine surgeon experience—a more experienced surgeon would likely have shorter surgical times and therefore higher payment and wRVU rates. Finally, using operative time alone may be problematic as there are other metrics involved in calculating wRVU and payment rates that are not publicly available. However, in our methods, the valuation of each procedure was determined against similar types of procedures, which carry comparable levels of complexity, technical aptitude, and risk.

Certain shoulder and elbow payment and RVU assignments may potentially be misvalued due to inaccurate operative times. Without changing reimbursement across all codes in a given subset of subspecialty procedures, such as shoulder arthroscopy, isolated procedures can be individually altered to more accurately capture the benefits of performing such procedures. Finally, some procedures, such as arthroscopic rotator cuff repair and revision TSA, can vary greatly in complexity and operative time, warranting additional subcoding to accurately define the extent of work performed. Although procedure reimbursement is multifactorial and complex in nature, compensation can be better aligned with patient-reported outcomes and surgery complexity to reflect the realities of performing such procedures. This realignment can be accomplished with the help of specialist societies that provide CMS with surgical time and effort data.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

SUPPLEMENTARY MATERIAL

Supplementary material is available in the electronic version of this paper at the CiOS website, www.ecios.org.

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