Original Article

Not all primary total hip arthroplasties are equal—so is there a difference in reimbursement?

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Background: Relative value units (RVUs) are a physician reimbursement model based on the effort required, or value, in providing a procedure or service for a patient. Procedures such as conversion total hip arthroplasties (THAs) can be compared to primary THAs, but many studies have revealed increased difficulties in conversion cases. Despite the increased time and effort for conversion THA, it is unknown if this is reflected in the RVU compensation model. Therefore, the purpose of this study was to compare the: (I) mean operative times; (II) mean RVUs; (III) RVU/minute for primary and conversion THAs; and (IV) perform an individualized idealized surgeon annual cost difference analysis.

Methods: A total of 103,702 primary THA patients were identified using CPT code 27130 and 2,986 conversion THA patients were identified using CPT code 27132 using the National Surgical Quality Improvement Program (NSQIP) database. The mean RVUs, operative times (minutes), and RVU/minute were calculated and compared. An annualize cost analysis of dollar amounts per case, day, and the year was also performed.

Results: The mean operative times for the primary and conversion THA cohorts were 94 *vs.* 146 minutes (P<0.001) and mean RVUs were 21.24 *vs.* 25.68 (P<0.001). Interestingly, the mean RVU per minute was higher for the primary THA compared to the conversion THA groups (0.26 *vs.* 0.21, P<0.001). Annualized cost analysis revealed a potential $173,529 difference from performing primary *vs.* conversion THAs.

Conclusions: Even though conversion THA can be considered to a more complex and demanding procedure, based on RVUs per minute of surgery, orthopaedic surgeons are reimbursed better for primary THA cases. This data could be used by orthopaedic surgeons to administer their practices better to yield the highest return on time.

Keywords: Reimbursement; relative value units (RVUs); primary; total hip arthroplasty (THA)

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Introduction

Relative value units (RVUs) were first implemented in 1992 based on a 1988 Harvard study by Hsiao *et al.* (1) as part of the resource-based relative value system (RVBRS) to determine physician compensation. The study was commissioned by the federal government in response to concerns regarding Medicare spending and low reimbursement in primary care (2). The reimbursement model originally proposed by Hsaio *et al.* (1) described three factors that should determine physician compensation: (I) time or work associated with providing a service, (II) cost of operating a practice, and (III) the opportunity cost of physician training (1-3). On average, the physician work component (work RVU) represents about half of the total RVU (2) and is intended to be proportional to physician time, effort, and technical skill in providing the service; and therefore, appropriately reflect physician reimbursement (2,4,5).

Multiple factors are used to determine reimbursement within the RVU model. For instance, the given RVU for a service provided is multiplied by a set dollar amount as well as other factors such as geographic practics costs like regional wage variations, costs of living, and malpractice premiums (6). Hence the RVU designation determines the Medicare fee for service. Some potential flaws with the RVU-based compensation system have, however, been identified. For example, studies suggest that cognitive care continues to be undervalued relative to surgical procedures (7,8). Additionally, although the RVBRS intention was to provide higher compensation for the physician services that require more work, there is limited evidence of this in the literature. Furthermore, while a few studies have found a correlation between measures of physician effort and RVUs (9,10), many others have challenged the model (11-13).

Few studies have assessed the ability of RVU-based reimbursement to accurately reflect procedural complexity in different fields of medicine (6,14) with limited data regarding the RVU model performance in orthopedics. In fact, to the best of our knowledge, there are no studies analyzing the use of the RVU model with respect to various types of hip arthroplasty, specifically conversion hip arthroplasty [conversion of a previous hip surgery to THA, with or without autograft or allograft (15)]. Therefore, the purpose of this study was to determine whether RVUs adequately capture the complexity, technical skill, and aftercare in primary versus conversion THA. Specifically, we compared: (I) mean operative times; (II) mean RVUs; (III) RVU per unit of time between primary and conversion THAs; and (IV) performed an individualized surgeon annual cost difference analysis.

Methods

Database

The American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP) database was used to identify patients who underwent primary and conversion THA between 2008 and 2015. The ACS-NSQIP is a nationally validated database that collects preoperative through 30-day postoperative data based on 135 variables for hundreds-of-thousands of cases (16). Data is collected at each contributing hospital by trained surgical clinical reviewers who are audited annually to ensure accuracy (16). This study was exempted from review by the Institutional Review Board as the database is publically available and contains de-identified data.

Current Procedural Terminology (CPT) codes

CPT codes, maintained by the American Medical Association, represent discrete physician services and are used as universal identifiers in order to determine reimbursement across all payers. We used category 1 CPT codes which directly link to procedures or services performed. Category 2 CPT codes are used for supplemental tracking and are optional, while category 3 CPT codes are provisional codes for new technologies, procedures, or services (17). For this study, CPT 27130 was used to identify primary THA, while CPT 27132 was used to identify conversion THA.

THA procedure selection

Primary and conversion hip arthroplasty were chosen for this study, since hip arthroplasties make up a large part of the overall expenditure of CMS (18). In fact, some estimates report CMS programs to pay for roughly 65% of all hip replacements in the United States, totaling nearly $40 billion (19). Furthermore, because conversion THA is the first time a prosthesis is implanted in a patient, it can fall under the realm of a primary case. However, recent reports have found that compared to primary THAs, conversion THAs require more intra- and post-operative

resources, and are more similar to a revision THAs than primary THAs (20-22). Therefore, it is important to make the distinction between primary and conversion total hip arthroplasties both operatively and financially.

Primary THA patient selection

Using CPT code 27130, a total of 104,209 primary THA cases were identified from the NSQIP database. Of this total number of cases, 441 (0.4%) cases which had recorded operative times of less than 30 minutes were excluded (very unlikely value, most likely a data entry error), yielding 103,768 (99.6%). Sixty-six cases (0.06%) out of the 103,768 cases that had a recorded operative time greater than 480 minutes were also excluded (also, outliers values, most likely due to inaccuracy in data entry). This resulted in a total of 103,702 primary THA cases, with operative times between 30 to 480 minutes that were included for final analysis in the current study. Women made up 57,451 (55%) of cases, while men made up 46,172 (45%) of cases. Seventy-nine cases (0.08%) did not have gender recorded.

Conversion THA cases

CPT 27132 was used to identify 3,004 conversion THA cases. Conversion THA was defined as: conversion of a previous hip surgery to THA, with or without autograft or allograft (15). Of the 3,004 cases, 11 cases (0.4%) had operative times recorded as less than 30 minutes and were excluded from analysis. Of the remaining 2,993 cases, 7 cases (0.2%) had operative times greater than 480 minutes, and were also excluded from the analysis. This resulted in 2,986 conversion THA cases with operative times between 30 and 480 minutes, which were included in the analysis. Of the 2,986 cases, 1,656 (55%) were women, while 1,330 (45%) were men.

Annual cost difference analysis

An annualized cost difference analysis was performed at an individual surgeon level performing primary or conversion THAs. We used 8 hours of operative time per day and an estimated 160 operative days per year (365 days/year, less 104 weekend days, less 14 days for vacation, less 5 federal holidays, less 1/3 of remaining days for non-operative days). Based on the mean operative times found, in 1 day a surgeon could either complete 5 primary THA or 3 revision THAs in one operating room. The Centers for Medicare and Medicaid Services reports an RVU conversion factor of $35.8887/RVU. The RVU/minute for each cohort was calculated by dividing the RVU assigned to each case by the operative time, in minutes, for that particular case. From the RVU conversion factor and the RVU/minute, a dollar amount per minute for both primary and conversion total hip arthroplasties was calculated. Dollar amounts per case were calculated by multiplying the dollar amount per minute and mean operative time. A daily reimbursement was calculated by multiplying the per-case reimbursement by the number of cases completed each day (5 primary or 3 conversion). From these values, a daily reimbursement difference was calculated and multiplied by 160 operative days, resulting in the annual dollar amount difference an adult reconstructive surgeon can be reimbursed for only performing primary THAs.

RVUs analysis

Work RVUs were identified from the NSQIP database using the variable name "WORKRVU." RVUs were defined as work RVUs in this study. Because congress requires CMS to continuously update the RVU system no less than every 5 years, the same CPT code can have different RVUs assigned to it for different years. During the review, CMS can update any RVUs assigned to a procedure if it is determined to be incorrectly valued. In order for the updates to occur, The American Medical Association/ Specialty Society Relative Value Scale Update Committee (RUC) compares surveys sent to physicians in the field, focusing on their time, effort, and practice expenses for providing particular procedures or services, to reference services in order to create new RVU recommendations. Based on these recommendations, CMS can then choose to update RVUs. In 2014, 76% of RUC recommendations were accepted by CMS (23).

Operative time analysis

Operative times were identified from the NSQIP database using variable name "OPTIME". Operative times that were recorded to be less than 30 minutes or greater than 480 minutes were not included for analysis. We felt these data points were potential errors in data collection, as some of these cases had negative or zero recorded operative times. Only a few cases (approximately 0.5%) were excluded. Nevertheless, the up-to-date and accurate NSQIP database, and over 100,000 cases were used for analysis.

Table 1 Primary *vs.* conversion total hip arthroplasty

Variable	Primary THA	Conversion THA	P
Total number	103,702	2,986	–
RVU, mean (range)	21.24 (20.72 to 21.79)	25.68 (25.49 to 25.69)	<0.001
Time (min), mean (range)	94 (30 to 480)	146 (30 to 469)	<0.001
RVU/min, mean (range)	0.26 (0.04 to 0.73)	0.21 (0.05 to 0.86)	<0.001

THA, total hip arthroplasty.

Data analysis

Mean RVUs, mean operative times, and RVU/minute were calculated using a Microsoft Excel spreadsheet (2013 Microsoft Office Professional Plus; Redmond, WA). These values were then compared between primary and revision THA cohorts. A cutoff P value of <0.05 was set to determine statistical significance of results. All Statistical analyses were performed using SPSS version 24 (International Business Machine Corporation, Armonk, New York, USA).

Results

Mean operative times

The mean operative times were 94 minutes (range, 30 to 480 minutes) for primary THA, and 146 minutes for conversion THA (range, 30 to 469 minutes). The mean operative times for primary THA were significantly lower than conversion THA (P<0.001) (*Table 1*).

Mean RVUs

The mean RVUs for the primary THA cases were 21.24 (range, 20.72 to 21.79). The mean RVUs for the conversion THA cases were 25.68 (range, 25.49 to 25.69). The 21.24 mean RVUs for primary THA were found to be significantly lower than the 25.68 mean RVUs for conversion THA cases (P<0.001) (*Table 1*).

Mean RVU/minute

The mean RVU/minute for the primary THA cases was 0.26 (range, 0.04 to 0.73), while the mean RVU/minute for the conversion THA cases was 0.21 (range, 0.05 to 0.86). The 0.26 mean RVU/minute for primary THA cases was found to be significantly greater than the 0.21 RVU/minute for conversion THA cases (P<0.001) (*Table 1*).

Annual cost difference analysis

The reimbursement rate for primary THA was found to be $9.33 per minute (0.26 RVU/minute × $35.8887/RVU), while for conversion THA, it was found to be $7.54 (0.21 RVU/minute × $35.8887/RVU). Each primary THA was found to be reimbursed at $877.12 per case, yielding a daily net of $4,385.60 for performing 5 primary THAs in 8 hours. Conversion THAs are reimbursed at $1,100.35 per case, or $3,301.04 per day for performing 3 conversions cases. The daily difference for performing primary *vs.* conversion cases amounts to $1,084.56. Thus, the annualized cost difference for an individual surgeon performing primary THAs instead of conversion THAs is $173,529.04 (*Table 2*).

Discussion

The Health Care Financing Administration (now CMS) implemented the RVBRS in 1992 in response to concerns for the increasing health care spending and low reimbursement for cognitive clinical encounters (1,2). The physician work component of the RVU is maintained by panels of physician societies and intends to allocate reimbursement that is in accordance with the time, physical and mental effort, psychological stress, and technical skill necessary to provide the service (1-3,6). It, therefore, follows that physicians should receive a higher rate of compensation for more complex procedures. There is evidence that conversion THA is a relatively frequent procedure that has longer operative times, more intraoperative blood loss, longer lengths of hospital stay, and higher costs than primary THA (24-27). Surgeons should therefore receive a higher rate of compensation for conversion THA. In the present study, we found that this is not necessarily the case. Although mean RVUs were higher for conversion than primary THAs the mean operative times for conversion THA were also higher. Therefore, when correcting the

Table 2 Individual surgeon cost analysis

Cost factor	Primary THA	Conversion THA
RVU/min	0.26	0.21
$/min	$9.33	$7.54
$/case	$877.12	$1,100.35
Cases/day	5	3
$/day	$4,385.60	$3,301.04
Daily cost difference	$1,084.56	
Annualized cost differences	$173,529.04	

THA, total hip arthroplasty.

RVUs for the time spent in surgery, the mean RVU/minute for primary THA was higher than for conversion THA (0.26 *vs.* 0.21, P<0.001). These data show that surgeons can earn a higher rate of reimbursement, and potentially almost $200,000 annualized difference, by preferentially performing primary THAs rather than the more complex conversion THAs. The main driving forces to such a large reimbursement differences are both the reimbursement rate as well as the number of cases which can be performed in a single day.

Like this study, others have shown evidence that RVUs do not correlate well with measures of physician work. Schwartz *et al.* (11) used the NSQIP database to show that emergent colectomy, total hernia repair, and biliary procedures were associated with significantly higher mortality risk, longer lengths of stay, and rate of complication than the corresponding elective procedures, despite their identical RVU designations. Similarly, Shah *et al.* (12) found that RVUs were poorly correlated with operative time, lengths of stay, and mortality. A study by Balasubramanian *et al.* (28) showed that work RVUs were poorly correlated with complexity of diagnosis and interpretation time in pediatric echocardiography. Additionally, Resnick *et al.* (13) demonstrated significant discrepancies between RVUs and hospital revenue generated between surgical specialties, which indicates that surgeons in some fields are not compensated in accordance with their value to the hospital.

Nguyen *et al.* (9) used the NSQIP database to show that that RVUs were correlated with overall complications and surgical site complications in plastic surgery procedures. However, their study included patients undergoing multiple concomitant procedures, making the results difficult to generalize to orthopaedics. In addition, it was not clear that the rate of complications alone was a sufficient measure of physician work. Another study by Little *et al.* (10) found that RVUs were correlated with operative time in pediatric surgical procedures. However, the study only included outpatient procedures and those that required less than one inpatient day of surgeon follow-up. The results are thus difficult to generalize to other, more complex procedures and those performed on adult populations.

There were several limitations to this study. Due to the retrospective nature and design, we were limited to data that was collected previously. There may be some unavoidable selection bias associated with the NSQIP database, as not all cases are included in it. Nonetheless, the NSQIP database contains prospectively collected data from a wide range of surgical centers, which improves its generalizability. Additionally, operative times less than 30 minutes or greater than 480 minutes operative times were excluded in our analysis. However, these were only a very few number of cases (approximately 0.5%), and were likely incorrectly coded. In addition, the NSQIP database does not account for variation in technical skill or work performed outside of the operating room, such as aftercare and clinic visits during the 90-day post-operative window. These are also important factors, which when considered, would likely further increase the RVU/minute discrepancy as conversion THAs tend to require greater overall care than primary THAs. Nevertheless, these factors should still be included for analysis in future studies.

While THA is a common treatment for end stage hip osteoarthritis, it is also often performed to treat failures or complications related to existing hardware due to previous fracture fixation or osteotomies (24,29,30). Numerous studies have found evidence that conversion THAs are

a more complex procedure than primary THAs, and requires more physician work (31). Schwarzkopf *et al.* (25) found that, compared to primary THA, conversion THA had a significantly longer operative time and hospital stay (P<0.05). Additionally, conversion THA increased the likelihood of requiring revision-type components, and the likelihood of requiring metaphyseal/diaphyseal fixation. Chin *et al.* (26) demonstrated that conversion THA had several significantly higher cost variables than primary THA, including a 29.2% higher cost associated with services provided by healthcare providers. In addition, Newman *et al.* (27) demonstrated that conversion THA resulted in increased perioperative blood loss and transfusion requirement. The RVU model was designed to reflect physician time, work, costs and the opportunity costs of training. However, while conversion THA has been shown to be more technically demanding with increased patient risk, it does not appear to be reflected in per minute compensation.

Conclusions

Published RVUs indicate that higher physician reimbursement is assigned for conversion THA than for the less complex primary THA. However, our data show that the actual increase in RVUs did not offset the increased time requirement of conversion THA. The mean RVU/minute of primary THA was significantly greater than that of conversion THA (0.26 *vs.* 0.21, P<0.001) and the cost analysis reviled a potential $173,529 difference. These data challenge the actual RVU model, and potentially prompt for a review of relative-value based compensation of orthopaedic surgeons. Although RVUs were designed with the intention of providing appropriate and proportional compensation to a physician work and skill, this study showed that an orthopaedic surgeon would potentially receive a higher hourly reimbursement by selectively performing primary THA over more complex and demanding conversion THA.

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Footnote

Conflicts of Interest: M Chughtai: Cymedica; DJ Orthopaedics; Peerwell; Performance Dynamics Inc.; Refelection; Sage Products; Stryker. MA Mont: AAOS; Abbott; Cymedica; DJ Orthopaedics; Johnson & Johnson; *Journal of Arthroplasty*; *Journal of Knee Surgery*; Mallinckrodt Pharmaceuticals; Microport; National Institutes of Health (NIAMS & NICHD); Ongoing Care Solutions; Orthopedics; Orthosensor; Pacira; Peerwell; Performance Dynamics Inc.; Sage; Stryker; Surgical Technologies International; Kolon TissueGene. The other authors have no conflicts of interest to declare.

Ethical Statement: This study was exempted from review by the Institutional Review Board as the database is publically available and contains de-identified data.

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