Defining Value in Hip and Knee Arthroplasty in the United States

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The quality of health care is influenced by, and is defined differently according to, the perspectives of the various stakeholders (i.e., surgeons, patients, hospitals, the United States government, and private payers).

Reconciling these differences is a challenge to hip and knee arthroplasty surgeons and is important for the future of health care in terms of value-based purchasing, pay for performance, and furthering innovation in new joint replacement products and technologies.

Sound, well-conducted cost-benefit and other economic analyses of hip and knee arthroplasty-related products and procedures are critical elements of value-based orthopaedic care and are facilitated by the recent trend toward greater transparency regarding health-care costs and charges.

Value-based health care has become a topic of intense debate in discussions on health-care reform. With recent governmental interventions, understanding the role of value in orthopaedic surgery is an absolute requirement. It is critical that we properly define the elements needed to measure value, which is defined as quality over cost, or health outcomes achieved per dollar spent. It is the numerator in the value equation—i.e., quality (health outcomes)—that presents the most important challenge as there are many ways to define and measure quality. Analogous to economic cost analyses, there are varying points of view regarding the definition of quality and, therefore, value. Different stakeholders, including patients, surgeons, hospitals, the government, and private payers, have different opinions and priorities when it comes to what is important in determining the outcome of a procedure or treatment (Fig. 1). It is this shared common goal of value that unites stakeholders, but varying perspectives and agendas create a divide in terms of defining quality.

Total hip arthroplasty and total knee arthroplasty are two of the most successful operations available in terms of improving quality of life. Total hip arthroplasty has been reported to have a nearly 80% rate of implant survival at more than thirty years postoperatively, and total knee arthroplasty has been reported to have a 96% rate of implant survival at fifteen to twenty years. The calculated quality of well year (QWY) is $5572 for primary total hip arthroplasty and $10,775 for revision total hip arthroplasty, comparable with those reported for other procedures such as gastric bypass. While total hip arthroplasty and total knee arthroplasty are recognized as beneficial and cost-effective treatments for patients who have joint disease, the scrutiny with which these procedures are

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being measured is intensifying in the wake of health-care reform. Rapid growth in volume and projected increases for total hip arthroplasty and total knee arthroplasty, coupled with costs that account for the largest expenditure category for Medicare, have drawn heavy attention from policymakers. National health-care spending reached $2.7 trillion in 2011 and accounted for 17.9% of the gross domestic product, stressing the need for change. Even more alarming are the projected values, driven by an aging population, of $4.7 trillion and 19.6%, respectively, by the year 2021.

Despite the success of total hip arthroplasty and total knee arthroplasty, there is substantial room for improvement in terms of quality and cost, with an annual total knee arthroplasty failure rate of approximately 1% and patient satisfaction rates ranging from 82% to 89%. In addition to patient dissatisfaction, potential postoperative complications add a negative effect to quality metrics and cost. Rastogi et al. reported on the costs associated with potentially avoidable complications, which included the Centers for Medicare & Medicaid Services-defined hospital-acquired complications and all readmissions. More than thirty complications, including vascular catheter-associated infection, fluid and electrolyte disturbances, blood incompatibility, hemorrhage, air embolism, and many others, were considered to be potentially avoidable complications. Analysis of claims data for commercially insured patients undergoing total hip arthroplasty (n = 2076) and total knee arthroplasty (n = 3403) revealed that the costs related to potentially avoidable complications were $7.8 million and $12.7 million, respectively. Current health-care initiatives to improve quality and outcomes have not necessarily realized their goals. An estimated $700 billion per year is spent in the United States on health-care services that do not translate into improved outcomes.

After metrics have been carefully chosen to meet the needs of all stakeholders, it is important to evaluate how these metrics perform in terms of improving quality.

**Elements of Performance Measures and Quality Improvement**

Historically, our health-care system has been centered on fee for service, rewarding volume with little or no concern regarding quality. As focus shifts to a value-based methodology that relies on appropriate patient indications and acceptable outcomes, we must consider the critical elements for performance measures. The list of important considerations in terms of psychometric properties is long and includes content validity, responsiveness, test-retest reliability, floor and ceiling effects, internal consistency, accessibility, and construct validity. Additional factors such as the burden on respondents and administrators and the method of administration take into account the time and cost to implement the instrument.
Donabedian's conceptualized three quality-of-care dimensions: (1) structure (the setting where care is delivered), (2) process (following good medical practices), and (3) outcome (the impact of care on health status). According to this model, structure and process are easily measured and can be manipulated, with outcomes reflecting the combined effects of changes to these dimensions. However, adherence to process-driven measures, such as the Surgical Care Improvement Project (SCIP) infection-prevention measures, has been reported to have no significant association with a lower probability of infection, demonstrating that the concept described by Donabedian does not always hold true. Similarly, Ingraham et al. evaluated the association between four SCIP surgical site infection process measures (SCIP-1 [prophylactic antibiotic administered within one hour prior to incision], SCIP-2 [appropriate antibiotic administered], SCIP-3 [prophylactic antibiotics discontinued within twenty-four hours postoperatively], and SCIP-6 [appropriate preoperative hair removal]) and four American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) risk-adjusted outcomes (thirty-day morbidity, serious morbidity, surgical site infection, and mortality). Data from >40000 hospitals participating in the ACS NSQIP were obtained from the Hospital Compare web site, including hospital discharges between January 2008 and December 2008. Fifteen of the sixteen analyses demonstrated a nonsignificant relationship, with the exception of that between SCIP-2 (appropriate antibiotic prophylaxis) and surgical site infection (p = 0.004), emphasizing the predominant failure of these process measures to ultimately influence outcomes. These results call to question whether process-of-care measurements can serve as appropriate surrogates of quality.

Perspectives on Defining Quality
Quality relative to total hip arthroplasty and total knee arthroplasty is influenced and defined by a variety of stakeholders, including orthopaedic surgeons, patients, hospitals, the United States government, and private payers.

Surgeons
The goals of total hip arthroplasty and total knee arthroplasty are to relieve pain and to restore function. In orthopaedics, many outcomes tools have been designed and implemented to assist the surgeon in assessing outcomes. Alviar et al. performed a systematic review on outcome instruments that are used following total hip arthroplasty and total knee arthroplasty and found twenty-eight options. Collins and Roos reviewed the eleven most commonly used instruments in terms of content, method of administration, respondent and/or administration burden, floor and ceiling effects, test-retest reliability, construct and content validity, and responsiveness. In short, these tools can be subdivided into patient-completed instruments and clinician-administered instruments. The most commonly used patient-completed questionnaires for the knee and hip are the Hip Dysfunction and Osteoarthritis Outcome Score (HOOS), the HOOS physical function short form (HOOS-PS), the Knee Injury and Osteoarthritis Outcome Score (KOOS), the KOOS physical function short form (KOOS-PS), the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), the Oxford Hip Score, and the Oxford Knee Score. The most commonly used clinician-administered tools are the Harris hip score and the Knee Society Score (although the latter was not included in the review by Collins and Roos). Noble et al. recently developed a new Knee Society scoring system because of the criticisms questioning the validity, reliability, responsiveness, and under-representation of patient expectations in the original. The new validated scoring system is a combination of clinician and patient-completed items and contains sections to better characterize patient expectations and satisfaction.

Patients
Many factors influence patient satisfaction, including pain relief, the restoration of function, and the ability to meet patient expectations. A clear link has been shown between patient expectations and patient satisfaction, both of which have been further tied to patient outcomes. The importance of meeting patient expectations in achieving patient satisfaction has been a consistent theme in the literature on total joint replacement. Age, sex, comorbidities, pain, and previous total joint surgery have been reported to impact patient expectations regarding joint...
arthroplasty. Patient satisfaction has emerged as a key component in determining quality of care and has been included in the Centers for Medicare & Medicaid Services Hospital Inpatient Value-Based Purchasing (HIVBP) program, which links reimbursements and incentives to the results of patient satisfaction surveys (detailed below).

The concerns, priorities, and expectations of patients and surgeons regarding the outcome of total hip arthroplasty or total knee arthroplasty are often different. Trousdale et al. reported that the primary concerns of patients undergoing total hip arthroplasty and total knee arthroplasty are the amount of pain that they will experience postoperatively and the time to recovery. Some authors have suggested that patients may in fact be overly optimistic in terms of postoperative pain (with 85% of patients expecting to be pain-free and 43% actually being pain-free), the time to full recovery (with an expected time of 4.7 months and an actual time of 6.1 months), and activity limitations (with 52% of patients expecting no limitations and 20% actually having no limitations). Moran et al. reported a substantial difference between patient and surgeon expectations following total hip arthroplasty and total knee arthroplasty. These differences emphasize the importance of surgeons and patients engaging in shared medical decision-making, facilitating communication between these stakeholders, and allowing surgeons to better understand and appropriately manage patient expectations.

While total knee arthroplasty and total hip arthroplasty have been shown to be highly successful for relieving pain and for restoring range of motion and function, studies in the literature have shown that only 82% to 89% of patients who are managed with primary total knee arthroplasty (n = 253 to 1703) are satisfied with the results of surgery, whereas the rate of satisfaction with function has been reported to range from 70% to 84%. Recent work has helped to elucidate important insights regarding patient satisfaction. Noble et al. estimated that 52% of patients who were managed with total knee arthroplasty reported some degree of limitation in functional activities and demonstrated that the gap between patients who had undergone total knee arthroplasty and control patients widened as activities became more demanding. These data suggest that patients place a high priority on functional activities.

Hospitals
Hospitals are challenged with decreasing reimbursements combined with rising health-care expenditures (specifically, implant costs). Reducing and/or controlling costs is an economic approach to improving value, which must be done carefully so as not to compromise the quality of patient care. Management’s focus on financial incentives rather than clinical needs has strained the doctor-hospital administrator relationship and has been implicated in trends of increased cost and inefficiency. Ranawat et al. described four initiatives that were implemented to align administrators and physicians with the common goals of improved patient care, satisfaction, and safety by focusing on enhanced efficiency while allowing for growth and cost containment.

Several methods are used to decrease implant costs, including negotiated vendor discounts, price-capitation, and gainsharing programs. Gainsharing is a hospital-physician partnership that is used by hospitals to incentivize physicians to be active participants in cost-cutting initiatives to improve value. In a basic sense, gainsharing is a performance-improvement strategy that motivates participants to be actively involved in the process by sharing financially in any improvements realized (i.e., the gain). Typically, performance is measured through a predetermined formula and is compared with baseline performance, with improvement savings being shared among participants. Considered illegal by the Office of Inspector General in 1999, gainsharing has had a resurgence following modifications to the advisory position in 2005.

Government
The Centers for Medicare & Medicaid Services use several claims-based measures to assess the quality of care of Medicare beneficiaries, including the Agency for Healthcare Research and Quality (AHRQ) Patient Safety Indicators and Inpatient Quality Indicators, hospital-acquired complications, the HIVBP program, readmission measures, and complications measures (for total hip arthroplasty and total knee arthroplasty only). In addition, a system specifically designed to capture data on quality and outcomes, named the Centers for Medicare & Medicaid Services/Premier Hospital Quality Incentive Demonstration, was developed and implemented in July 2003. This six-year voluntary collaborative effort included hip and knee surgery as one of the five clinical areas of focus and calculated a composite quality score based on surgical processes. In Year 1, hospitals that performed in the ninetieth percentile received a bonus (2% of diagnosis-related group payments for total hip arthroplasty and total knee arthroplasty for the given year), hospitals with a performance rating in the second decile received a 1% diagnosis-related group bonus, and hospitals performing in the top 50% earned recognition. This system was replaced in Year 3 by a three-tiered award/payment system. Additional changes in Year 4 included a penalty methodology, in which hospitals that did not score above the ninth or tenth decile threshold (set in Year 2) received a 1% to 2% reduction, respectively, in their Medicare payment. During this time period, additional surgical process quality measures and measures of surgical outcome were included, such as thirty-day readmission.
rates (Table I). This effort provided a framework for moving forward and improving on historical reimbursement methods, with many more changes to come.

The Medicare Payment Advisory Commission reported estimates as high as $12 billion in Medicare expenditures for potentially preventable thirty-day hospital readmissions. This realization led the Commission to submit several recommendations to Congress in 2008, including the publication of hospitals’ risk-adjusted rehospitalization rates, which would then be tied to reimbursement. The Patient Protection and Affordable Care Act, signed into law in 2010 and upheld in 2012, began the expansion of this pay-for-performance (P4P) methodology to all United States hospitals to promote quality improvements leading to better patient outcomes. Financial penalties, to be applied by Centers for Medicare & Medicaid Services beginning in 2013, were established, initially targeting hospitals with above-average risk-adjusted readmission rates for pneumonia, acute myocardial infarction, and heart failure. Rastogi et al.\textsuperscript{14} analyzed claims data on 2076 total hip arthroplasty and 3403 total knee arthroplasty procedures that were performed in 2005 and 2006. Avoidable readmissions carried the highest cost of all potentially avoidable complications, with an additional burden of over $3 million (total hip arthroplasty) and $5 million (total knee arthroplasty). Jencks et al.\textsuperscript{41} reported a 9.9% thirty-day rehospitalization rate for major hip or knee surgery, which accounted for 1.5% of all rehospitalizations in their review of the Medicare claims data from 2003 and 2004. The most frequent reason for readmission was aftercare (10.3%), followed by major hip or knee problems (6.0%), pneumonia (4.2%), and postoperative infection (3.1%). While some published studies on the experiences and lessons from the Hospital Quality Initiative Demonstration have shown that the pay-for-performance methodology is associated with some improvements in terms of the processes of care\textsuperscript{42,43} Jha et al.\textsuperscript{44} found no evidence to support a decrease in thirty-day mortality rates.

The Centers for Medicare & Medicaid Services HIVBP program has elected to use the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) survey to assess patient satisfaction. The HCAHPS Patient Experience of Care Domain is a thirty-two-question survey designed to evaluate a patient’s overall satisfaction with a given hospital admission\textsuperscript{45}. The survey includes sections on nursing care, physician care and communication, hospital environment, discharge processes, and details about the patient that are known to affect satisfaction (e.g., mental health, education, etc.). Only three of the questions specifically target patient satisfaction with his or her doctor and address communication. In 2014, the Patient Experience of Care Domain will constitute 30% of a hospital’s total performance score\textsuperscript{46}.

**Private Payers**

The Affordable Care Act has been projected to result in 26 million new customers in the health-care market as well as a >40% decline in profit margins for insurers by 2019\textsuperscript{37}. A recent report by the Boston Consulting Group summarized their results after interviewing 120 private payer executives from forty-eight of the largest commercial payers, including national plans, Blue Cross Blue Shield plans, regional plans, and focused-segment and integrated-model payers. That report demonstrated that private payers have been proactive in their approach to transitioning into this new health-care climate and are

<table>
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<tr>
<th>Clinical Condition/Measure</th>
<th>Used in Year 6 Payment Model</th>
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<tr>
<td>Prophylactic antibiotic received within 1 hour prior to surgical incision</td>
<td>Yes</td>
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<tr>
<td>Prophylactic antibiotic selection</td>
<td>Yes</td>
</tr>
<tr>
<td>Prophylactic antibiotic discontinued within 24 hours after end of surgery</td>
<td>Yes</td>
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<tr>
<td>Recommended venous thromboembolism prophylaxis ordered</td>
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<tr>
<td>Appropriate venous thromboembolism prophylaxis within 24 hours prior to surgery and up to 24 hours after surgery</td>
<td>Yes</td>
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<tr>
<td>Beta-blocker therapy during perioperative period</td>
<td>Yes</td>
</tr>
<tr>
<td>CMS 30-day readmission rate (3M-All Patient Refined-diagnosis-related group risk adjustment)</td>
<td>Yes</td>
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<tr>
<td>AHRQ patient safety composite</td>
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<tr>
<td>Appropriate care measure</td>
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<td>AHRQ inpatient quality indicators in-hospital mortality rate</td>
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<tr>
<td>CareScience complication measure</td>
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<tr>
<td>Risk-adjusted average length of inpatient hospital stay</td>
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*CMS = Centers for Medicare & Medicaid Services, and AHRQ = Agency for Healthcare Research and Quality.*
shifting to a business-to-consumer model. Private payers are responding to health-care reform through three main initiatives, which they have described as (1) redesigning the operating model, (2) capturing the retail customer, and (3) diversifying revenue streams. The first initiative is focused on cost, including both managing medical costs and reducing administrative costs, whereas the second and third initiatives are focused on growth. More than 90% of the survey respondents stated that managing cost is the top priority, and these efforts range from traditional (e.g., lowering reimbursement rates) to experimental (e.g., outcomes-based initiatives). The potential for outcomes-based approaches to impact cost has led many private payers to pursue quality initiatives. Only 40% of national plans have prioritized quality-focused programs, compared with 70% of regional and Blue Cross Blue Shield plans. Many national plans are adopting pay-for-performance reimbursement models, shifting some risk to hospitals and other health-care providers. The Medicare Shared Savings Program section of the Affordable Care Act allows for the establishment of Medicare and private payer Accountable Care Organizations (ACOs) to encourage coordinated care and to offer risk-sharing and potential cost-savings.

Costs
In an effort to increase transparency regarding health-care costs, the Centers for Medicare & Medicaid Services recently made data on costs for services associated with the 100 most common Medicare inpatient services and thirty most common outpatient services from 3000 hospitals publicly available, including what individual hospitals charge Medicare and what hospitals actually get paid. These data revealed a shocking disparity among hospitals with regard to the average total charges for a given procedure. A notable example highlighted in Orthopedics Today showed that the average total charges for a joint replacement were $5300 in Ada, Oklahoma, compared with $223,000 in Monterey Park, California.

Hospital charges and reimbursement are not the only highly variable components to consider in terms of cost containment. Robinson et al. analyzed hospital and device costs associated with total hip arthroplasty and total knee arthroplasty from sixty-one hospitals and found that the median ratio of implant cost to total surgical cost was 43.5% (range, 12.7% to 87.1%) for total knee arthroplasty and 50.2% (range, 15.0% to 87.2%) for total hip arthroplasty. The cost of total hip arthroplasty and total knee arthroplasty implants consumes nearly 50% of Medicare reimbursements to hospitals. Prosthetic waste has been reported to occur in 2% of procedures, with the surgeon and operating room staff at fault approximately 73% of the time, accounting for an annualized cost of $36,019,000 when applied across the United States. In that particular study, the hospital absorbed 67% of the waste-associated costs.

To better understand the sources of cost for total hip arthroplasty and total knee arthroplasty, Marshall et al. analyzed Canadian health-care resource use over the continuum of care, including preoperatively, during the hospital stay, and postoperatively (during the acute and long-term recovery phases) to create a costing model that incorporated both payer and patient perspectives. Payer costs included everything from the general practitioner visit during which the patient is diagnosed with musculoskeletal disease to operating room charges to physiotherapy. Patient costs included medications, travel to the clinic and hospital, and time off work. Approximately 60% of the total costs for these procedures were incurred during the inpatient stay, with the other 40% incurred during preoperative management and postoperative recovery and rehabilitation. That study emphasized the need to consider the continuum of care when assessing the value of total hip arthroplasty and total knee arthroplasty as well as the need to consider costs from both a payer and a patient perspective.

There is potential to shift and/or decrease costs with the use of protocol-driven care pathways. This approach often requires more dollars to be spent on some services in order to reduce the need for others. Studies have shown that optimized care pathways are associated with decreased postoperative lengths of stay, lower blood transfusion rates, and earlier mobilization.

As new technologies continue to enter the market, it is increasingly important to determine the cost-effectiveness of these technologies and to determine which patients will be most appropriately served by these potential improvements in spite of increased financial costs. Metal-on-metal hips and ceramic hips offer increased durability at an average increase of $2500 over the shelf price of standard implants. Gioe et al. found that premium implants were associated with an increase of approximately $1000 in comparison with standard implants and did not demonstrate improved survival rates at seven to eight years after surgery. The extent to which these increased costs are realized by improved outcomes is largely unknown when the premium implants are made available on the market and requires careful cost-benefit analyses.

Aligning Goals
Ultimately, patient satisfaction is the goal of all orthopaedic procedures and has clearly emerged as a major metric. There is some controversy with regard to the most appropriate way to measure and interpret these data as patient satisfaction is influenced by a multitude of factors, which are often outside of the physician’s control. A prominent health-care economist envisioned an outcome hierarchy for knee osteoarthritis and highlighted the failure of current processes to fully capture patient outcomes. This hierarchy consists of a three-tier system in which Tier 1 measures survival and the degree of recovery (e.g., function, pain, ability to return to work, physical activity). Tier 2 measures the recovery process in terms of time to recovery, return to function, and
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<td>Total hip arthroplasty</td>
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<td>Marinelli et al.61 (2008)</td>
<td>Cemented versus cementless</td>
<td>Cost-effectiveness</td>
<td>Payer</td>
<td>Lifetime</td>
<td>No difference in cost saving between two types of implants</td>
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<td>Lifetime</td>
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<td>Cost-effectiveness</td>
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<td>QWY = $5776</td>
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<td>Fordham et al.64 (2012)</td>
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<td>Cost-effectiveness (Exeter Primary Outcomes Study [EPOS] patients)</td>
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<td>Cost-utility (Scottish arthroplasty registry)</td>
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<td>Hybrid versus cemented ICER = $4010/QALY. Hybrid implants had highest probability of being most cost-effective for all subgroups except women with an age of ≥80 yr, for whom cemented were most cost-effective</td>
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<td>Mota68 (2013)</td>
<td>Early total hip arthroplasty versus late total hip arthroplasty versus no surgery</td>
<td>Cost-effectiveness (Markov model)</td>
<td>Payer</td>
<td>Lifetime</td>
<td>Early surgery versus late surgery: ICER = $1440/QALY (men) and $679/QALY (women). Late surgery versus no surgery: $676/QALY (men) and $120/QALY (women)</td>
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<td>Krummennauer et al.69 (2009)</td>
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<td>Cost-effectiveness (prospective trial)</td>
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<td>WOMAC-based MCER = $2900 ($)QALY, EQ-SD-based MCER = $4950 ($)QALY</td>
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<td>Xie et al.70 (2010)</td>
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<td>Cost-utility (nonrandomized prospective cohort)</td>
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<td>Cost-effectiveness (Knee Arthroplasty Trial)</td>
<td>Payer</td>
<td>5 yr</td>
<td>ICER = $12,091 ($)QALY</td>
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<td>Custom cutting blocks versus traditional instrumentation</td>
<td>Cost-effectiveness (Markov model)</td>
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<td>20 yr</td>
<td>Custom cutting blocks for total knee arthroplasty will not be cost-effective unless they result in a significantly reduced revision rate</td>
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<td>Jenkins et al.66 (2013)</td>
<td>Total knee arthroplasty</td>
<td>Cost-utility (Scottish arthroplasty registry)</td>
<td>Payer</td>
<td>Lifetime</td>
<td>$3235 ($)QALY</td>
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*Societal perspective includes direct costs of treatment (hospital stay, prosthesis, medications) as well as indirect costs (loss of productivity), whereas payer perspective includes only direct costs. †All incremental cost-effectiveness ratios (ICERs) have been converted to 2012 USD and adjusted for inflation using the medical component of the Consumer Price Index. MCER = marginal cost-effectiveness ratio. QALY = quality-adjusted life year. QWY = quality well year.
disutility of care (e.g., pain, length of stay, infection, early revision), and Tier 3 measures sustainability (e.g., the rate of revision or reoperation) and consequential new health problems (e.g., loss of mobility, risk of fracture). While providers are the main driver of this outcome hierarchy and are incentivized to efficiently achieve high-quality outcomes, all stakeholders must collectively determine whether these models are accurate and reliable for measuring the success of an outcome.

Rastogi et al.14, using the Prometheus Payment Model and a national database of 2005 to 2006 claims data for 4.5 million commercially insured patients, constructed evidence-informed case rates (condition-specific formulas capable of setting a severity-adjusted global price for a given condition treated for a defined period of time). Complications were severity-adjusted and were able to be separated, holding the healthcare system appropriately responsible for payments related to poor management of care (i.e., potentially avoidable complications) but not for risks inherent to the patient’s health.

Future Directions

Well-conducted cost-minimization, cost-effectiveness, cost-utility, and cost-benefit analyses are needed to assess the most efficient uses of our limited health-care resources. Bozic et al.58 tested the cost-effectiveness of alternative bearing surfaces and provided a strategy for their most appropriate use. In the United Kingdom, Davies et al.59 reviewed the economic literature to determine whether there was enough evidence to assist with selecting total hip arthroplasty implants. The findings were not surprising, with the authors concluding that there are limited cost studies, not enough long-term survival data, and a general lack of patient and societal perspectives. As important as these economic analyses are, there is wide variability in their quality.60

Over the past five years, thirteen economic evaluations of total hip arthroplasty and total knee arthroplasty have been published (Table II).61-72 Cost-effectiveness is commonly analyzed in terms of the incremental cost-effectiveness ratio (ICER), defined as the extra cost per unit of outcome obtained when comparing two treatments. Total hip arthroplasty and total knee arthroplasty have been shown to be cost-effective, with ICERs ranging from $2123 to $16,144 (Table II). From a health policy standpoint, interventions costing less than $20,000 are considered to be cost-effective.73 While newer procedures such as hip resurfacing arthroplasty and the use of total knee arthroplasty custom cutting blocks may provide modest gains in quality of life, these gains do not yet justify the increased costs.56,72 Surgeons and institutions should consider these economic evaluations when determining their support of newer technologies.

Implant registries have demonstrated the potential for improving costs by reducing revision rates. In two studies based on data from the Swedish Total Hip Replacement Register, a 10% decrease in the revision rate corresponded to estimated savings of $140 million.74,75 Luo et al.76, in a report on 19,224 procedures that had been performed with components identified by the Australian Registry as performing poorly, found that the revision rate would have decreased by 28.6% if even average-performing designs had been chosen. It was estimated that these practice changes could save 10.2% of direct costs. The large amount of data from multiple surgeons that are made available by these national joint registries offers an alternative to the randomized controlled trial, which is the current gold standard for evaluating innovation in implant design.77 Unfortunately, efforts in the United States to establish a National Arthroplasty Registry have been fraught with practical issues, including excessive burden of time on clinical care providers, excessive cost, and the failure to define a legal framework for governance.78

This is an exciting but extremely complicated era in health care, with opportunities to improve outcomes and measure costs. With the lack of a clear definition for quality and several methods of managing costs, there is no single formula to measure value. There is a need for peer-reviewed literature to help guide health-care providers in making choices in terms of best practices and cost management. Opportunities for physicians to affect new health-care policies will present themselves, and it is critical to be vocal during these discussions.

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References

8. Kurtz S, Ong K, Lau E, Mowat F, Halpern M. Projections of primary and revision hip and knee arthroplasty in the United States from...


44. Scott NB, McDonald D, Campbell J, Smith RD, Carey AK, Johnston IG, James KR, Breusch SJ. The use of enhanced recovery after surgery (ERAS) principles in Scottish orthopaedic units—an implementation and follow-up at 1 year, 2010-2011: a report from the
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