An Epidemiologic Analysis of Clinical Practice Guidelines for Non-Arthroplasty Treatment of Osteoarthritis of the Knee

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Purpose: To analyze the current practice patterns of non-arthroplasty treatment of knee osteoarthritis (OA) and to assess the impact of the American Academy of Orthopaedic Surgeons clinical practice guidelines on the management of OA of the knee, particularly as they relate to the use of arthroscopic treatment. **Methods:** The United Healthcare Database (2004-2009, 11 million patients, 216 million records) was used for the study and was searched using Boolean language for *International Classification of Diseases, Ninth Edition, Clinical Modification* and Current Procedural Terminology, fourth revision codes. A reference group was defined as patients treated with knee arthroplasty in 2009 and diagnosed with knee OA in the same record. Clinical practice patterns in the 5 years preceding arthroplasty were analyzed in this group. **Results:** The reference group consisted of 12,806 patients undergoing total knee arthroplasty in 2009 with a documented diagnosis of OA at the time of surgery, with prior nonoperative treatment strategies analyzed during the preceding 5 years (2004-2009); 10.0% of patients were prescribed physical therapy specific to OA, 2.6% received an unloader brace, 0.52% underwent acupuncture, 43.5% were administered intra-articular corticosteroids, and 15.4% received viscosupplementation injections. During the 5 years before arthroplasty, 2,505 patients (19.6%) underwent arthroscopy and debridement/lavage, 35% of whom did not have a diagnosis code for mechanical pathology. Within 1 year of knee arthroplasty, 2,028 of the 2,505 knee arthroscopies (80.9%) were performed. **Conclusions:** The findings show that significant gaps do exist between the evidence-based American Academy of Orthopaedic Surgeons recommendations and actual practice patterns in the United States between 2004 and 2009. **Level of Evidence:** Level IV, diagnostic study.

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The authors report the following potential conflict of interest or source of funding: A.D. receives support from Smith & Nephew and Biomet. R.C.M. receives support from KNG Health Consulting and National Institutes of Health. B.B.Y. is president and CIO of the PearlDiver unit of AFCell Medical and owns stock options and stock in AFCell Medical. B.J.C. receives support from DePuy, Arthrex, Regentis, Carticept, Zimmer, and Smith & Nephew.

Received October 30, 2012; accepted September 5, 2013.

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0749-8063/12706/$36.00

http://dx.doi.org/10.1016/j.arthro.2013.09.002

Osteoarthritis (OA) is the leading cause of disability among older patients and a major source of health care costs in the United States. The prevalence of knee OA in adults aged older than 45 years has been estimated at 17% of the total population, with approximately 9.3 million adults given a diagnosis of symptomatic knee OA in 2005 alone.[1-3] Arthritic conditions were estimated to increase health care expenditures by $185.5 billion per year between 1997 and 2007.[4] Although there is no known cure for the disease, a myriad of pharmacologic, nonpharmacologic, and surgical treatment strategies have been described in the literature with the aim of reducing pain and physical disability, limiting the progression of joint damage, and improving health-related quality of life.[1,2]

In response to rising health care costs, attention has turned to optimizing treatment strategies that curb the use of interventions that offer little benefit to the patient. One of these initiatives includes the development of clinical practice guidelines (CPGs) that include a formal evaluation of available interventions for a particular disease state developed through a combination of expert

Table 1. AAOS CPGs for Non-Arthroplasty Treatment of Knee OA

	AAOS Recommendations	Yes (+) or No (−)	Strength of Evidence
Social and well being			
1	Self-management educational programs, activity modifications	+	IIB
2	Regular contact to promote self-care	+	IVC
3	Weight loss (for patients with BMI >25)	+	IA
Rehabilitation			
4	Low-impact aerobic fitness exercises	+	IA
5	Range of motion/flexibility exercises	+	VC
6	Quadriceps strengthening	+	IIB
Mechanical intervention			
7	Patellar taping for short-term pain relief	+	IIB
8	Lateral heel wedge for medial-compartment OA	−	IIB
9	Brace with valgus-directing force for medial unicompartmental OA	+/−	II, inconclusive
10	Brace with varus-directing force for lateral unicompartmental OA	+/−	V, inconclusive
Complementary and alternative therapy			
11	Acupuncture	+/−	I, inconclusive
12	Glucosamine and/or chondroitin sulfate or hydrochloride	−	IA
Pain relievers			
13	Acetaminophen, NSAIDs for pain	+	IIB
14	If there is a GI risk, comorbid conditions, history of PUD/GI bleed, or concurrent steroids or anticoagulant, the patient should take acetaminophen, topical NSAIDs, nonselective NSAIDs plus gastroprotective agent, or COX-2 inhibitor	+	IIB
Intra-articular injections			
15	Intra-articular steroid injection for short-term pain relief	+	IIB
16	Intra-articular HA injection	+/−	I/II, inconclusive
17	Needle lavage	−	I/IIB
Surgical intervention			
18	Arthroscopy with debridement or lavage, primary diagnosis of OA	−	I/IIA
19	Arthroscopic partial meniscectomy or loose body removal, primary signs and symptoms of torn meniscus and/or loose body with symptomatic OA	+	VC
20	Tibial tubercle osteotomy for isolated patellofemoral OA	−	V, inconclusive
21	Realignment osteotomy in active patients with unicompartmental OA with malalignment	+	IV/VC
22	Free-floating interpositional device for unicompartmental OA	−	IVB

BMI, body mass index; COX, cyclooxygenase; GI, gastrointestinal; HA, hyaluronic acid; NSAIDs, nonsteroidal anti-inflammatory drugs; PUD, peptic ulcer disease.

consensus and evidence-based systematic review of the literature. Several organizations have developed CPGs to optimize the treatment of knee OA, including the American College of Rheumatology, European League Against Rheumatism, and Osteoarthritis Research Society International.[1,5,6] Most recently, in 2008 the American Academy of Orthopaedic Surgeons (AAOS) published a CPG entitled "Treatment of Osteoarthritis of the Knee"[7] to assist physicians in their treatment of patients with knee OA (Table 1). Each recommendation includes both a grade and level of supporting evidence (Table 2).

Over the past several years, published work from a number of different institutions has reported on the utility of arthroscopy for the treatment of OA of the knee. Although there are certainly dissenters, the general consensus among this body of work shows the ineffectiveness and low yield of arthroscopy as a treatment for non-mechanical OA pain of the knee.[8-14]

In this study we aimed to descriptively and quantitatively analyze the non-arthroplasty treatment of knee OA using information obtained from a recognized national database and to compare our findings with

Table 2. Description of AAOS Recommendations and Level of Evidence

Grade	AAOS Guideline Language	Explanation
A	"We recommend"	Good evidence (Level I studies with consistent findings) for or against recommending intervention
B	"We suggest"	Fair evidence (Level II or III studies with consistent findings) for or against recommending intervention
C	"Option"	Poor-quality evidence (Level IV or V studies) for or against recommending intervention
I	"We are unable to recommend for or against"	Insufficient or conflicting evidence, not allowing a recommendation for or against intervention

evidence-based recommendations. Thus the purpose of this study was to analyze the current practice patterns of the non-arthroplasty treatment of knee OA and to assess the impact of the AAOS CPGs on the arthroscopic management of OA of the knee. We hypothesized that among the AAOS recommendations that could be evaluated using our specific database, practice patterns in the United States between 2004 and 2009 would closely align with the evidence-based recommendations of the AAOS CPGs.

Methods

Source Database and Study Group

The United Healthcare database (UHD) was used. The UHD consists of inpatient, outpatient, and physician charges from orthopaedic records within the database, which covers approximately 10% of private-payer insurance in the United States. This database spans from 2004 to 2009 and allows for full patient tracking through outpatient, inpatient, and physician-directed orthopaedic care.

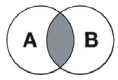
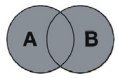
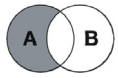
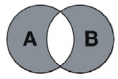
To characterize a specific population, we collaborated with PearlDiver Technologies (Fort Wayne, IN) to create a subset of patients within the searchable database of Health Insurance Portability and Accountability Act–compliant records from orthopaedic patients included in the UHD. These patient records were searched by use of *International Classification of Diseases, Ninth Edition, Clinical Modification* codes, as well as Current Procedural Terminology, fourth revision (CPT-4) codes (Table 3). The PearlDiver database allows for cross-referencing and searching of health care data with Boolean search language (Table 4).

Table 3. Diagnosis (ICD-9) and procedure (CPT) Codes Used to Mine Database

Treatment/Diagnosis	CPT/ICD-9 Code
OA	715.16, 715.26, 715.36
Unicompartmental, patellar, total arthroplasty	27446, 27438, 27447
Rehabilitation	97001, 97002
Heel wedge/knee orthosis/bracing	97760 with L3350, 99070 with L1843, L1844, L1845

CPT, Current Procedural Terminology; ICD-9, *International Classification of Diseases, Ninth Edition.*

Table 4. Boolean Operations Supported by PearlDiver Patient Record Database

Operation	Result
AND	
OR	
NOT	
XOR	

A, all patients who correspond to 1 specific *International Classification of Diseases, Ninth Edition* or Current Procedural Terminology code; B, all patients who correspond to different, specific *International Classification of Diseases, Ninth Edition* or Current Procedural Terminology codes.

NOTE. AND refers to those data points that are included in both Groups A and B. OR refers to those data points that are included within Group A or Group B, including those datapoints in both groups. NOT refers to data points that are contained within one group, and specifically not part of the other. XOR refers to datapoints that are included within Group A or Group B, but excluding those that are included in both groups.

We created 2 reference groups: an index group consisting of patients with end-stage OA and a broader group of all patients diagnosed with OA. These groups were taken only from the last year of the database (2009) to allow examination of treatments over several years (2004-2009). The index group was defined as patients who were treated with any knee arthroplasty (total knee, unicompartmental, or patellofemoral arthroplasty) in 2009 and had a diagnosis of OA in the same record as the arthroplasty. The broader group simply consisted of all patients with a diagnosis code for knee OA in 2009.

AAOS Clinical Practice Guidelines

To examine practice patterns addressed by the AAOS CPGs for the treatment of OA, the CPT-4 codes that represent the discussed treatments were searched in all available years of the database (2004-2009) and cross-referenced with the reference group described earlier. The CPGs can be organized into broad topics covering a wide range of non-arthroplasty treatment modalities

Table 5. Proportion of Patients Undergoing Specific Non-Arthroplasty Treatments for OA

Guideline	End-Stage Group*	Broader Group†
5 and 6: Rehabilitation	10.0% (1,286/12,806)	25.9% (146,891/566,027)
7-10: Mechanical interventions	2.6% (329/12,806)	1.0% (5,187/566,027)
11 and 12: Complementary and alternative therapy	0.52% (66/12,806)	0.4% (2,103/566,027)
15: Intra-articular corticosteroid injections	43.5% (5,580/12,806)	16.6% (93,348/566,027)
17: Intra-articular viscosupplementation	15.4% (1,972/12,806)	6.3% (35,725/566,027)
18: Arthroscopy with debridement or lavage	6.8% (877/12,806)	3.7% (21,349/566,027)
19: Arthroscopy with meniscus treatment and/or loose body removal	12.8% (1,628/12,806)	7.7% (43,518/566,027)
20 and 21: Osteotomy	0% (0/12,806)	0.002% (1,113/566,027)

*Defined as all patients undergoing knee arthroplasty in 2009, the last year of the database. All treatments in the preceding 5 years were examined.

†Defined as all patients diagnosed with knee OA in 2009, the last year of the database. All treatments in the preceding 5 years were examined.

for knee OA (Table 1). For example, recommendations 4, 5, and 6 suggest that patients with symptomatic OA of the knee should be encouraged to participate in low-impact aerobic fitness exercises and quadriceps strengthening exercises, rendering support for physical therapy (PT) in these patients before definitive end-stage treatment. Recommendations 9 and 10 outline mechanical interventions for OA such as the use of a varus-directing brace and valgus-directing brace for patients with lateral- and medial-compartment joint degeneration, respectively. Recommendation 11 addresses complementary and alternative medicine, specifically acupuncture, to be used as an adjunctive therapy for pain relief in patients with symptomatic knee OA. Intra-articular injections using corticosteroids and hyaluronic acid are discussed in recommendations 15 and 16, respectively. The final recommendations provide evidence for or against non-arthroplasty surgical treatment options for knee OA, including arthroscopy with debridement or lavage in patients with symptomatic knee OA (recommendation 18), arthroscopic partial meniscectomy or loose body removal in patients with appropriate clinical findings (recommendation 19), and the use of osteotomies in patients with unicompartmental knee OA (recommendations 20 and 21).

Database Mining Method

The following represents an example of the descriptive examination of the CPGs in the context of the UHD. Recommendation 21 states that realignment osteotomy is an option in active patients with symptomatic OA. For this CPG, the database was searched for patients with the diagnosis of OA (*International Classification of Diseases, Ninth Edition* codes 715.16, 715.26, and 715.36) between the years 2004 and 2009. Then, by use of Boolean language, the database was searched for patients who received a realignment procedure (CPT-4 codes 27457, 27418, and 27450) between the years 2004 and 2009 before their end-stage arthroplasty and who also had a diagnosis of OA (the reference group).

By use of the described method, descriptive analyses were carried out for each relevant CPG that required a CPT-4 diagnosis code, enabling a quantitative analysis of how many patients, with a given diagnosis of OA, received said procedure. The important assumption was made that physician coding is reliable and accurate for the various treatment modalities.

Results

The index group was composed of 12,806 patients, defined as those who were treated with any knee arthroplasty (total knee, unicompartmental, or patellofemoral arthroplasty) in 2009 and had a diagnosis of OA in the same record as the arthroplasty; 566,027 patients formed the broader group of all patients diagnosed with knee OA. A summary of the results organized by CPG is shown in Table 5.

PT/Rehabilitation

In the index group, 1,286 patients (10.0%) were prescribed and coded for rehabilitation or PT specific to OA of the knee during the 5 years preceding treatment with arthroplasty. In the broader group, 146,891 (25.9%) received PT at some point between these years. More specifically, 46,726 patients (8.2%) were coded for both OA and PT on the same day, suggesting that at least 8% of these patients received OA-directed PT.

Mechanical Intervention

We next analyzed the frequency with which clinicians in practice prescribed mechanical interventions such as heel wedges and varus-/valgus-directing knee braces for knee OA between 2004 and 2009. No patients (0%) were prescribed a heel wedge in the index group. Furthermore, 329 patients (2.6%) were prescribed a brace with either a varus- or valgus-directing force in the index group. In the entire group of patients diagnosed with knee OA, 5,187 patients (1.0%) were prescribed a brace with either a valgus- or varus-directing force.

Complementary and Alternative Therapy

Only 66 of the 12,806 patients in the index group (0.52%) were coded for acupuncture therapy specific to OA of the knee during the 5 years preceding end-stage

treatment. In the broader group, 2,103 patients (0.4%) were coded for acupuncture treatment.

Intra-Articular Injections

In the index group, 5,580 of the 12,806 patients (43.5%) were administered intra-articular corticosteroid injections within 5 years of end-stage treatment; 93,348 of the 566,027 patients in the broader group (16.6%) were administered intra-articular corticosteroids.

Regarding viscosupplementation, 1,972 of the 12,806 patients in the index group (15.4%) were administered viscosupplementation injections within 5 years of arthroplasty. In addition to the patients diagnosed with OA and without an end-stage procedure, 35,725 of the 566,027 patients in the broader group (6.3%) were administered intra-articular viscosupplementation.

Non-Arthroplasty Surgical Options

For non-arthroplasty surgical options, such as arthroscopy, we found that 2,505 of the 12,806 patients in the index group (19.6%) underwent arthroscopy with debridement or lavage during the 5 years preceding arthroplasty. We further analyzed the time course during which these patients underwent arthroscopy followed by more definitive treatment. Surprisingly, our results showed that 96.9% of these patients (2,427 of 2,505 patients) had arthroscopic surgery within 3 years, 91.9% (2,302 of 2,505) underwent arthroscopy within 2 years, and 80.9% (2,028 of 2,505) underwent arthroscopy within 1 year of arthroplasty. In other words, of all patients undergoing arthroscopy before definitive surgical intervention, approximately 81% had knee arthroscopy within 1 year of end-stage treatment, 10.9% had knee arthroscopy between 1 and 2 years before treatment, and 4.9% had knee arthroscopy between 2 and 3 years before arthroplasty.

Further analysis shows that 877 of the 12,806 patients in the index group (6.8%) without a coded diagnosis for a meniscal tear or loose body (i.e., those for whom the AAOS has recommended against arthroscopic intervention) still underwent arthroscopy with debridement or lavage at some point during the 5 years preceding end-stage treatment. Similar to the findings mentioned previously, further analysis shows that most of these procedures took place within 1 year of definitive arthroplasty: 96.6% of these 877 patients (847 of 877) had arthroscopic surgery within 3 years of end-stage treatment, 90.1% (798 of 877) underwent arthroscopy within 2 years, and 78.7% (690 of 877) underwent arthroscopy within 1 year of end-stage treatment.

When these findings are taken together, of the 2,505 patients who had arthroscopy within 5 years of undergoing knee arthroplasty, 877 (34.9%) underwent this procedure without a diagnosis of meniscal tear or loose body. Of the 19.6% of patients from the index group who underwent arthroscopy before definitive management, approximately 12.8% were coded for a diagnosis of both OA and meniscal tear or loose body whereas 6.8% underwent arthroscopy for a code of OA only; moreover, the vast majority of arthroscopic procedures in both groups (>75%) occurred within 1 year of definitive intervention.

In the broader group, 64,867 of the 566,027 patients (11.5%) diagnosed with knee OA underwent arthroscopy for knee OA with debridement or lavage. Of these patients, 21,349 (32.9%) did not have a concurrent diagnosis of meniscal tear or loose body. Lastly, regarding osteotomy, of the 566,027 patients with a diagnosis of OA between 2004 and 2009, 1,113 (0.002%) received an osteotomy (tibial tubercle osteotomy, distal femoral osteotomy, high tibial osteotomy).

Discussion

We have presented a population-based descriptive analysis of current practice patterns for non-arthroplasty treatment of knee OA in the context of CPGs. The findings suggest that significant gaps exist between CPGs established by the AAOS in 2008 and current practice patterns in the non-arthroplasty treatment of knee OA in the United States.

We used the UHD for data extraction in this study. This has been used as a source of cohort, epidemiologic, and economic studies in orthopaedics, internal medicine, and general surgery, as well as other specialties.[15-19] The database spans from 2004 to 2009 and includes 11 million unique patients with over 216 million records related to the care and treatment of these patients. Patient demographics within the database include geographic region in the United States (South, Midwest, Northeast, and West), age (in 5-year increments), gender, and an encrypted patient identifier that allows for full patient tracking through outpatient, inpatient, and physician-directed orthopaedic care.

Incorporating evidence-based medicine into everyday clinical decision making can be challenging. Guidelines have been proposed as a way to assist physicians in the application of evidence-based medicine with the goal of improving the quality of care while potentially decreasing costs.[10-22] Guidelines may improve outcomes, minimize risk, and enhance efficiency. Successful application of guidelines requires efficient implementation, adherence, and updating policies.[23,24] Organizations must know which guidelines deserve greater focus for development of further evidence to strengthen the guidelines themselves and/or creation of incentives to adhere to those guidelines.

Regarding the CPGs examined in this study, several interventions appear to be underused. Only 10.0% of patients were coded for rehabilitation or PT specific to OA and 45% of patients received a corticosteroid injection for knee OA during the 5 years preceding knee arthroplasty. These 2 guidelines have relatively strong

support at grade B and with Level II evidence.[25-27] The CPGs suggest that heel wedges should not be used, and the recommendation for unloader braces is inconclusive. Consistent with the AAOS recommendations, our results suggest that physicians in practice are hesitant to prescribe mechanical aids for knee OA (only 2.6% of the patients were prescribed a mechanical aid for the treatment of end-stage OA in this study).[28-30]

One of the highest-profile interventions for pre-arthroplasty treatment of knee OA is arthroscopy. Several Level I and II studies have been published reporting the ineffectiveness of this treatment modality for the pain associated with OA of the knee without mechanical symptoms.[8-14] After review of the published data, the OA CPG AAOS multidisciplinary workgroup recommended against debridement and/or lavage without mechanical symptoms for patients with a primary diagnosis of OA.[7] In light of these guidelines and on the basis of our results, arthroscopic debridement may be performed more frequently than recommended, with the vast majority of these procedures being performed within 1 year of end-stage treatment. Approximately 20% of patients in our index group underwent debridement or lavage at some point during the 5 years before end-stage arthroplasty, and 80% of these patients had such a procedure within 1 year. Roughly 7% of patients with knee OA without a coded diagnosis for a meniscal tear or loose body (i.e., those for whom the AAOS has recommended against arthroscopic intervention) underwent arthroscopy, with most procedures occurring within 1 year of end-stage treatment. In other words, almost 35% of patients undergoing arthroscopy had no coded diagnosis for a meniscal tear or loose body (only OA) as recommended in the CPGs. In light of this and despite the mounting evidence of the ineffectiveness of knee arthroscopy as a treatment for OA of the knee without mechanical symptoms, this procedure continues to be performed and the modality overused.

Limitations

There are several limitations to this study. First, the findings reported in this article are largely descriptive and do not include an analysis of factors influencing adherence to guidelines, such as specialty (sports medicine *v* adult reconstruction *v* primary care) or patient characteristics (age, gender, and body mass index). The symptom presentation lacks any degree of granularity because many real-time factors used in clinical practice are not captured in the database. A significant gap probably exists between the expectations drawn from clinical studies in clearly defined environments and the results of many individual decision-making processes by experienced individual surgeons in complex clinical situations. For instance, it may be that some of the patients who underwent arthroscopy with a diagnosis of OA were relatively young and had fairly well-preserved joint spaces, and in some cases the arthroscopy may have been diagnostic to evaluate the true degree of degenerative changes or other reasons for pain rather than proceeding directly to joint arthroplasty. The database also does not capture the specialty of the physician providing care. For example, primary care physicians use nonoperative care, and sports medicine orthopaedists perform arthroscopy in addition to providing nonoperative care. Patient age may also affect what treatment is ultimately recommended.

Second, the database does not allow for the evaluation of every guideline. For example, treatment with exercise and weight loss cannot be assessed because of database limitations and our inability to accurately search for these factors by procedure code.

Third, we were unable to evaluate practice patterns before and after the guidelines were released. In our opinion, at least 5 years of post-guideline data should be required to properly evaluate practice patterns as a reflection of the impact of the CPGs. However, we also believe that this study is a necessary first step to guide effective implementation and adherence strategies.

Fourth, the accuracy of the findings of this study is limited by the accuracy with which physicians code diagnoses and treatments. Despite such discrepancies, the data contained within this study contain considerable value. Our findings have potentially uncovered important insight into the quality of physician coding, and future studies should attempt to address this pertinent issue.

Another limitation of this study can be seen in the mining protocol itself, which uses Current Procedural Terminology and *International Classification of Diseases, Ninth Edition* codes. An exhaustive search including interviews with practicing physicians and physical therapists was performed for all possible codes and combinations of codes; however, variations in coding may account for some irregularities in the dataset. Despite the limitations of coding, we used the best available methods for executing the purpose of this study. Future studies should include controlled experiments on implementation and adherence to guidelines, as well as population-based studies, to evaluate the impact of these guidelines. Future Level I studies should consider these findings.

Conclusions

The findings show that significant gaps do exist between the evidence-based AAOS recommendations and actual practice patterns in the United States between 2004 and 2009.

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