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Warren R. Dunn, Bruce R. Schackman, Colin Walsh, Stephen Lyman, Edward C. Jones, Russell F. Warren and Robert G. Marx

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VARIATION IN ORTHOPAEDIC SURGEONS' PERCEPTIONS ABOUT THE INDICATIONS FOR ROTATOR CUFF SURGERY

BY WARREN R. DUNN, MD, MPH, BRUCE R. SCHACKMAN, PHD, COLIN WALSH, BS, STEPHEN LYMAN, PHD, EDWARD C. JONES, MD, RUSSELL F. WARREN, MD, AND ROBERT G. MARX, MD, MSC, FRCSC

Investigation performed at The Hospital for Special Surgery, New York, NY

Background: Epidemiologic studies have demonstrated substantial variations in per capita rates of many surgical procedures, including rotator cuff repair. The purpose of the current study was to characterize orthopaedic surgeons' attitudes concerning medical decision-making about rotator cuff surgery and to investigate the associations between these beliefs and reported surgical volumes.

Methods: A survey was mailed to randomly selected orthopaedic surgeons listed in the American Academy of Orthopaedic Surgeons directory. Only individuals who had treated patients for a rotator cuff tear, or had referred patients for such treatment, within the previous year were asked to complete the two-page survey. The survey comprised fifteen questions regarding clinical opinion, including four regarding hypothetical cases. Clinical agreement was defined as >80% of the respondents answering similarly.

Results: Of the 1100 surveys that were mailed, 539 were returned (a response rate of 49%). Of the 539 respondents, 316 (58.6%) had treated or referred patients with a rotator cuff tear in the previous year. There was a significant negative correlation between the surgeon's estimation of the failure rate of cuff repairs in the United States and that surgeon's procedure volume ($r = -0.21$, $p = 0.0003$), indicating that surgeons with a lower procedure volume are more pessimistic about the results of surgery than are those with a higher procedure volume. Arthroscopic, mini-open, and open cuff repairs were preferred by 14.5%, 46.2%, and 36.6% of the respondents, respectively. Surgeons who performed a higher volume of procedures were less likely to perform open surgery ($p < 0.0001$). There was clinical agreement regarding only four of the nine clinical questions and none of the four questions about the hypothetical vignettes.

Conclusions: We found significant variation in surgical decision-making and a lack of clinical agreement among orthopaedic surgeons about rotator cuff surgery. There was a positive correlation between the volume of procedures performed by the surgeon and the surgeon's perception of outcome, with surgeons who had a higher procedure volume being more enthusiastic about rotator cuff surgery than those who had a lower procedure volume.

Substantial variation in the per capita rate of surgical procedures (area variation) is ubiquitous across many levels of geography and has been demonstrated for many musculoskeletal conditions[1-9]. There are several theories about the possible cause(s) of area variation. One explanation is the "professional uncertainty hypothesis," popularized by Wennberg and Gittelsohn, which postulates that area variation is the result of clinical uncertainty regarding the management of conditions for which there is no clinical consensus about treatment options[10]. Alternatively, Chassin proposed the "enthusiasm hypothesis," which postulates that the variation is due to differences in surgeons' enthusiasm for procedures, which may not be evidence-based[11].

In describing geographic variations in the rates of three common shoulder procedures—total shoulder replacement, humeral head replacement, and rotator cuff repair— Vitale et al. reported that the rates varied by state by as much as tenfold and that rotator cuff repair had the highest variation[3]. The variation was not related to surgeon density or surgeon subspecialty but was inversely related to population density. The indications for rotator cuff repair are unclear because the natural history of rotator cuff disease is not well documented[12]. Numerous studies have shown that many rotator cuff tears are completely asymptomatic[13-17]. Furthermore, the literature contains contradictory data regarding the efficacy of repair and the role of decompression. These factors, along with reports of

low postoperative healing rates[18-20], make it difficult to define the appropriate indications for rotator cuff repair. Hence, divergences in clinical opinions may be responsible for variations in the utilization of these surgical procedures, as has been observed to be the case for knee replacement and lumbar disc excision[21-23]. The purpose of this study was to characterize the variation in orthopaedic surgeons' attitudes concerning medical decision-making about rotator cuff surgery and to investigate the association between those beliefs and reported surgical volumes.

Materials and Methods

A two-page questionnaire was developed to quantify surgeons' opinions about surgical decision-making regarding the treatment of rotator cuff lesions (see Appendix). The questionnaire was reviewed and revised by a multidisciplinary panel consisting of an expert in medical decision-making (B.R.S.), an epidemiologist (S.L.), two shoulder surgeons (R.F.W. and E.C.J.), and a third shoulder surgeon with training in clinical epidemiology and experience with physician surveys (R.G.M.). Final iterations of this survey were first pilot-tested by four additional shoulder surgeons from different geographic regions. Pilot testing suggested that the survey was understandable and could be completed quickly (in approximately five minutes on the average). Feedback from the pilot-test subjects regarding questions was incorporated into the final survey.

Surgeons were asked whether they had "treated patients or referred patients for treatment for rotator cuff tears" within the past year. Surgeons who answered "no" to this question were excluded from subsequent analyses. The remaining surgeons were then asked how many rotator cuff repairs they had performed in the past year and whether they preferred an arthroscopic, mini-open, or open method of repair for a 2-cm full-thickness tear. The surgeons were also asked to estimate "the failure rate (defined as patient dissatisfaction) for all patients undergoing rotator cuff repair in the USA this year." Tertiles were used to define unbiased thresholds to determine whether the surgeon's volume of rotator cuff repairs, performed in the past year, was low, medium, or high. Tertiles are a type of percentile that divides a distribution into three equal groups, with each group containing one-third of the values; however, if the total number of values is not a multiple of 3, one of the groups will have an extra value.

The survey was divided into two major sections: four questions regarding hypothetical case presentations[24] and eleven questions about factors that might affect surgical decision-making.

Case Presentations

The hypothetical case presentations, in which it was stated that the rotator cuff tear had been confirmed by magnetic resonance imaging, were designed to address four different clinical presentations of cuff lesions that are potentially controversial. They included (1) a painful, partial-thickness tear in a laborer who had sustained a traumatic injury four months previously, (2) a full-thickness tear in a laborer with mild weakness and little pain who had sustained a traumatic injury three months previously, (3) a full-thickness tear in a fifty-five-year-old man with a one-year history of mild discomfort, and (4) a large, retracted tear with fatty infiltration of the cuff muscles in a patient who had sustained a traumatic injury one week previously. For each of the four hypothetical patients, the surgeons were asked to choose one of the following options: (1) no surgery, physical therapy; (2) no surgery, a cortisone injection; (3) surgery without cuff repair; and (4) surgery with cuff repair. In subsequent analysis, these four categories were collapsed into discrete responses (operative management and nonoperative management).

Factors That Affect Surgical Decision-Making

Of the eleven questions about factors that might influence decision-making regarding rotator cuff surgery (e.g., patient expectations, role of physical therapy, role of corticosteroid injection, relationship between cuff disease and shoulder osteoarthritis, and potential progression of the tear), nine were answered with use of a 5-point Likert scale (strongly disagree, disagree, indifferent, agree, and strongly agree). In subsequent analysis, these responses were collapsed into a 3-point scale (agree, indifferent, and disagree). Of the remaining two questions, one requested a numerical response concerning the maximum recommended number of steroid injections, and the other was a multiple-response question that addressed factors affecting the patients' ability to participate in surgical decision-making.

Clinical agreement has been inconsistently and somewhat arbitrarily defined in the literature. Wright et al. defined agreement as >90% of physicians answering similarly on a survey[23,25], whereas others have suggested that a value of >95% indicates strong agreement and a value of >60% indicates general agreement[26]. Marx et al. defined clinical agreement as 80% of surgeons answering similarly[27], and for the purposes of the study we defined clinical agreement as >80% agreement ac-

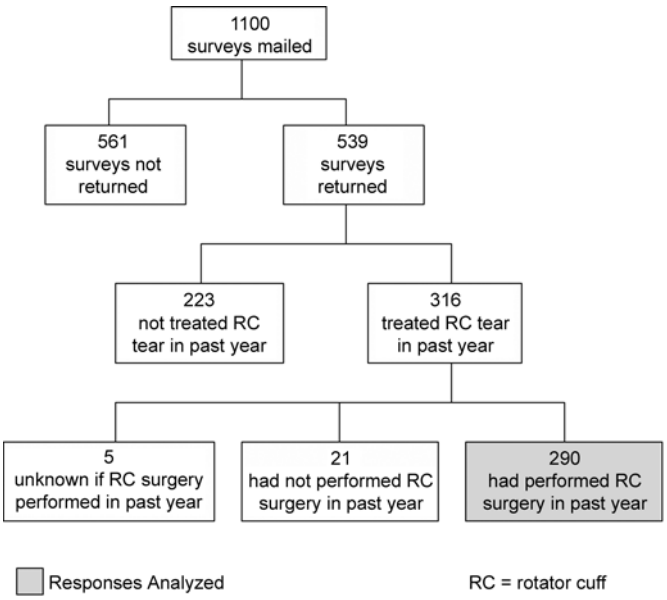

Fig. 1

A schematic of the AAOS sampling frame.

TABLE I Data According to Surgical Volume

	Low Volume	Medium Volume	High Volume	Total
Cases/yr				
Mean	10.4	25.9	72.9	38.7
Median	12.0	25.0	50.0	30.0
Minimum, maximum	1, 19	20, 38	40, 275	1, 275
Estimated failure rate *(%)*				
Mean	18.8	15.0	13.0	15.3
Median	20.0	15.0	10.0	15.0
Minimum, maximum	0, 50	0, 95	0, 70	0, 95
Region*				
Northeast	12 (22.6%)	20 (37.7%)	21 (39.6%)	53 (18.3%)
Midwest	19 (30.6%)	22 (35.5%)	21 (33.9%)	62 (21.4%)
West	26 (33.8%)	26 (33.8%)	25 (32.5%)	77 (26.6%)
South	21 (22.6%)	37 (39.8%)	35 (37.6%)	93 (32.1%)
Other	1 (20.0%)	1 (20.0%)	3 (60.0%)	5 (1.7%)
Preferred type of cuff repair†				
Arthroscopic	4 (9.5%)	8 (19.0%)	30 (71.4%)	42 (14.5%)
Mini-open	24 (17.9%)	60 (44.8%)	50 (37.3%)	134 (46.2%)
Open	48 (45.3%)	37 (34.9%)	21 (19.8%)	106 (36.6%)
Not reported	3 (37.5%)	1 (12.5%)	4 (50.0%)	8 (2.8%)

*Mantel-Haenszel chi-square test for trend: $p = 0.48$. †Mantel-Haenszel chi-square test for trend: $p < 0.0001$.

cording to the criteria used by Marx et al.

A sampling frame of orthopaedic surgeons was constructed with use of the 2002 membership directory of the American Academy of Orthopaedic Surgeons (AAOS), which contains contact information for approximately 20,756 surgeons. A total of 1100 orthopaedic surgeons were randomly selected from this frame to receive a survey by mail. A cover letter encouraging participation and signed by one of the authors of this study (R.F.W.) was included in the mailing[28].

For statistical analyses, the Mantel-Haenszel chi-square and Fisher exact tests were used to compare proportions and an independent-samples t test and one-way analysis of variance were used to compare mean values. Correlations were measured with use of the Spearman correlation coefficient. All analyses were performed with SAS for Windows 9.0 software (Cary, North Carolina).

Results

Of the 1100 surveys that were mailed, 539 were returned (a response rate of 49%) (Fig. 1). There was no significant difference between the surgeons who responded and those who did not respond in terms of geographic region (Fisher exact test, $p = 0.73$). Years of membership in the AAOS was used as a surrogate for years in practice. Respondents had been in practice for an average of eighteen years and nonrespondents, for an average of twenty years (t test, $p < 0.0001$).

Of the 539 surgeons who returned the survey, 316 (58.6%) indicated that they had treated patients with a rotator cuff tear in the past year. Twenty-one of the 316 had not performed any rotator cuff surgery in the past year, and five left the question regarding the number of rotator cuff repairs blank. These twenty-six surveys were excluded from subsequent analysis. The 290 respondents who reported that they had performed rotator cuff surgery in the past year form the basis of the survey analysis. Dividing the reported surgical volumes into tertiles provided a threshold of less than twenty cases per year for a low-volume practice, twenty to thirty-nine cases per year for a mid-volume practice, and forty or more cases per year for a high-volume practice.

There was a significant negative correlation between the surgeon's estimation of the failure rate in the United States and his or her surgical volume ($r = -0.21$, $p = 0.0003$), with surgeons who performed a lower volume of operations being more pessimistic about the results of rotator cuff surgery than those who performed a higher volume of operations. The mean estimated failure rate (and standard deviation) was 15.3% ± 11.5%. Arthroscopic, mini-open, and open cuff repairs were preferred by 14.5%, 46.2%, and 36.6% of the surgeons, respectively (Table I). The mean number of years in the AAOS was 9.4, 11.8, and 16.2 for surgeons indicating that their preferred method of cuff repair was arthroscopic, mini-open, and open, respectively. A significant difference between these means was identified by one-way analysis of variance ($p < 0.001$), and a post hoc Duncan test (alpha level = 0.05) demonstrated that surgeons who preferred an open cuff repair had been in practice longer than those who preferred the arthroscopic or mini-open technique. A significant inverse relationship was noted between the "invasiveness" of the preferred

TABLE II Percentage of Clinical Agreement Among Surgeons Regarding Factors Affecting Surgical Decision-Making

	Disagree	Indifferent	Agree
Clinical agreement*			
Rehab. should be discussed with patient preop.	2.1	0.4	97.6
Surgeon should explain options, let patient decide	3.8	2.8	93.4
Patient should expect "normal" shoulder after repair	85.7	3.8	10.5
Surgeon should spend more time discussing pros and cons preop.	2.8	15.0	82.2
Clinical disagreement			
Physiotherapy is useful for full-thickness cuff tears treated nonop.	11.1	9.7	79.2
Steroid injections are contraindicated in potential surgical candidates	73.3	10.4	16.3
Surgeon should decide and tell patient whether to have repair	76.6	8.0	15.4
Repair can prevent progression of tear	29.5	16.7	53.8
Repair can prevent osteoarthritis	51.4	17.4	31.3

*Clinical agreement is defined as >80% of respondents choosing one of the three response alternatives.

repair and the volume of procedures that the surgeon had performed ($p < 0.0001$). Those who performed a higher volume were less likely to prefer open surgery. Neither the preferred type of cuff repair nor the surgical volume appeared to be related to geography, as no differences were observed according to the United States geographic region (South, Northeast, West, or Midwest) when results were stratified by volume tertile ($p = 0.48$) or by preferred type of repair ($p = 0.09$).

There was clinical agreement regarding four of the nine clinical questions (Table II) and none of the four questions about the hypothetical vignettes (Table III). When the responses to the questions about the four hypothetical vignettes (Table IV) were stratified according to surgical volume tertile, a significant trend was found for surgeons with a higher procedure volume to be more likely to choose operative management for vignettes 1, 2, and 3 and less likely to choose operative management for vignette 4 (Table V).

When the nine questions regarding factors that affect surgical decision-making were stratified by surgical volume tertile, significant trends were found for two questions (see Appendix): surgeons with a higher procedure volume were more likely to agree that patients should expect to have a normal shoulder after rotator cuff repair and that a major reason to repair the rotator cuff is to prevent progression of the tear.

Five (1.7%), sixty-five (22.4%), 157 (54.1%), forty-three (14.8%), and seventeen (5.9%) of the respondents indicated that one, two, three, four, and five or more steroid injections, respectively, could be safely given in one year; three respondents did not answer this question. There was a significant negative correlation between the reported surgical volume and the respondent's opinion about the number of steroid injections that can be given safely in a year ($r = -0.19$, $p = 0.005$). In other words, surgeons with a higher procedure volume were less enthusiastic about multiple steroid injections than were surgeons with a lower procedure volume.

Discussion

There was considerable disagreement among the surgeons regarding most of the items in our survey. In fact, there was clinical agreement regarding only four questions and regarding none of the questions about the hypothetical case presentations. Eddy described three types of practice policies: standards, guidelines, and options[29]. Survey items with ≥95% agreement are considered "practice standards," items with <95% but ≥60% agreement are considered "practice guidelines," and items with <60% agreement are considered "practice options." According to Eddy's conceptual framework, only one item in our survey ("the expected frequency and duration of postoperative rotator cuff rehab should be discussed with patients preoperatively") could be considered a "practice standard," although ten items (including all four responses concerning the hypothetical cases) could be considered "practice

TABLE III Percentage of Clinical Agreement Among Surgeons Regarding Vignettes*

Vignette†	Operative Treatment	Nonoperative Treatment
1	65.2	34.8
2	76.9	23.1
3	24.5	75.5
4	36.9	63.1

*Clinical agreement is defined as >80% of respondents choosing one of the three response alternatives. There was disagreement regarding all vignettes. †See Table IV for a complete description of each vignette.

TABLE IV Description of Vignettes

Vignette	Description
1	A 35-yr-old manual laborer fell at work 4 mo ago onto the dominant arm and has a painful, 50% partial-thickness rotator cuff tear involving the entire supraspinatus tendon with no demonstrable weakness. His situation is unchanged after 3 mo of physical therapy.
2	A 45-yr-old manual laborer has a medium (2-cm), full-thickness rotator cuff tear after an acute injury 3 mo ago that involves the dominant arm with 4/5 external rotator weakness that is not particularly painful.
3	An active 55-yr-old man with an insidious history of mild discomfort present for a year is found to have a small (1-cm), full-thickness rotator cuff tear. He has received no treatment to date.
4	An active previously asymptomatic 65-yr-old woman reports a traumatic event one week ago and now cannot lift her arm. Magnetic resonance imaging reveals a large retracted (5-cm) cuff tear with fatty infiltration of the involved cuff muscles.

guidelines." This disagreement probably contributes to the geographic variation in rates of rotator cuff surgery.

Three potential sources of clinical disagreement among surgeons have been proposed by Wright et al.[25]: (1) lack of evidence, (2) controversy about existing evidence, and (3) lack of awareness and/or acceptance of existing evidence. The clinical disagreements described in the current study probably reflect all three of these explanations. Several authors have noted a lack of clinical evidence regarding partial and full-thickness rotator cuff tears and that they have an unclear natural history[12,28,30,31]. Many aspects of rotator cuff surgery are still controversial, and several studies have demonstrated conflicting results concerning such issues as nonoperative management of full-thickness tears[32], the role of débridement[33-37], arthroscopic compared with open techniques[38-40], and the role of acromioplasty[32]. Furthermore, even when good information is available in the literature, surgeons may not have been exposed to that information or, if they have, they may think that it is biased or flawed. These factors are probably influenced by the amount of training in shoulder surgery that they have completed.

In keeping with the "enthusiasm hypothesis," surgeons who have performed a higher volume of cuff repairs appear to be more enthusiastic about them. The responses to the questions about three of the four hypothetical cases showed a significant trend in which surgeons with a higher procedure volume were more likely than those with a lower volume to select operative management. This preference for operative intervention by surgeons with a high procedure volume may be appropriate and lead to better outcomes. Conversely, it is possible that the opinions of the surgeons with a low procedure volume are more accurate and that a factor contributing to high surgical volume is the surgeons' preference to operate. The opposite significant trend was noted for vignette 4, which was intended to depict an acute injury at the site of a chronic tear with fatty infiltration and, therefore, a potentially irreparable injury. This trend could reflect the fact that surgeons with a lower procedure volume did not appreciate the clinical scenario that the vignette intended to depict either because of a lack of clarity of the vignette or the surgeon's lack of knowledge of the available literature, or both.

Surgeons reporting a higher procedure volume in this study also estimated the failure rate of cuff repairs in the United States to be lower. An inverse relationship between reported volume and estimated failure rate, in which surgeons with a higher procedure volume perceived the outcome of surgery to be better than did those with a lower volume, has been shown in survey studies regarding total knee replacement[25,26]. There are several possible reasons for this finding. First, surgeons who believe that the surgical failure rate is low probably counsel patients accordingly and therefore offer surgery to more patients. Second, surgeons with a higher procedure volume may actually have lower failure rates themselves and may believe that their failure rates are more representative of average outcomes than they actually are.

We are aware of only two reports comparing the volume and outcome of shoulder surgery, and both dealt with shoulder arthroplasty[41,42]. In both studies, in which administrative data were utilized, the patients of surgeons with a high procedure volume had fewer complications and a shorter length of stay in the hospital compared with patients of surgeons with a low procedure volume. While there is a growing body of volume-outcome literature documenting better outcomes in

TABLE V Answers to Vignettes According to Surgical Volume

	Surgeons Choosing Operative Management				Mantel-Haenszel Chi-Square Test for Trend
Vignette	Low Volume	Medium Volume	High Volume	Total	
1	48 (60.8%)	62 (58.5%)	79 (75.2%)	189 (65.2%)	P = 0.03
2	49 (62.0%)	83 (78.3%)	91 (86.7%)	223 (76.9%)	P = 0.0001
3	4 (5.1%)	32 (30.2%)	35 (33.3%)	71 (24.5%)	P < 0.0001
4	36 (45.6%)	41 (38.7%)	30 (28.6%)	107 (36.9%)	P = 0.02

high-volume centers[43-47], these results should be viewed with caution because the studies are limited by the ecological fallacy[48], which can occur when inferences are made at the individual level on the basis of group-level data. For example, when measured at the patient level, the proportion of normal appendices that are removed is higher when surgery is delayed after the time of admission; however, when measured at the hospital level, the proportion of normal appendices that are removed is lower when surgery is delayed[49]. Further investigation is necessary to determine if the volume of cuff surgery is related to the failure rate and the patient-relevant outcome.

This study has several limitations. First, case volume was determined in our survey on the basis of the physicians' self-report, which is subject to recall bias. However, there is no evidence to suggest that recall bias is disproportionately greater for surgeons with a high procedure volume than it is for those with a low volume. Our sampling frame was limited to members of the AAOS, and, although we believe that a high proportion of rotator cuff repairs are performed by AAOS members (the AAOS membership department estimates that 96% of board-certified orthopaedic surgeons in the United States are AAOS members), we were unable to independently confirm this assumption. There was a small difference between the respondents and the nonrespondents in terms of the mean years of membership in the AAOS (eighteen and twenty years, respectively), but it seems unlikely that a mean difference of two years would significantly affect the results. Differential interpretation or misinterpretation of the questions may explain some of the differences in the surgeons' responses; for example, the different approaches to repair (arthroscopic, mini-open, and open) were not defined. We attempted to reduce this bias by limiting the survey to two pages, to avoid respondent fatigue, and by pilot testing the survey; however, limiting the survey length precluded additional questions about factors that could influence responses, such as educational background and fellowship training.

In summary, in our survey of orthopaedic surgeons, we found significant variation in surgical decision-making and a lack of clinical agreement about rotator cuff surgery. There was a positive correlation between surgical volume and the surgeons' perceptions of outcome, with surgeons with a high procedure volume appearing more enthusiastic about rotator cuff surgery than those with a lower volume. Additional study of the influence of surgical volume on decision-making and the outcome of rotator cuff surgery is warranted.

Appendix

eA The entire questionnaire and the detailed responses broken down by surgical volume are available with the electronic versions of this article, on our web site at jbjs.org (go to the article citation and click on "Supplementary Material") and on our quarterly CD-ROM (call our subscription department, at 781-449-9780, to order the CD-ROM). ■

Warren R. Dunn, MD, MPH
Vanderbilt Sports Medicine, 2601 Jess Neely Drive, Nashville, TN 37212.
E-mail address: warren.dunn@vanderbilt.edu

Bruce R. Schackman, PhD
Division of Outcomes and Effectiveness Research, Department of Public Health, Weill Medical College of Cornell University, 411 East 69th Street, New York, NY 10021

Colin Walsh, BS
Stephen Lyman, PhD
Edward C. Jones, MD
Russell F. Warren, MD
Robert G. Marx, MD, MSc, FRCSC
Sports Medicine and Shoulder Service (E.C.J., R.F.W., and R.G.M.) and the Foster Center for Clinical Outcome Research (C.W., S.L., E.C.J., and R.G.M.), The Hospital for Special Surgery, 535 East 70th Street, New York, NY 10021

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