JSES International 6 (2022) 167–174

Contents lists available at ScienceDirect

JSES International

journal homepage: www.jsesinternational.org

Shoulder conditions and health related quality of life and utility: a current concepts review

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ARTICLE INFO

Keywords:
Shoulder
Health-related quality of life
Cost-effectiveness
Utility analysis
Patient-reported outcomes
PROMIS
EQ-5D
SF-6D

Level of evidence: Narrative Review

Study of the outcome of treatment of shoulder conditions has emphasized subjective evaluation of outcomes including a variety of disease, region, and joint-specific tools. In response to the rapidly rising cost of health care, further interest has been directed to cost-effectiveness and value. Comparison of the outcomes of different shoulder conditions with each other, other musculoskeletal, and nonorthopedic conditions requires more generalized outcome tools, especially when considering cost-effectiveness and utility analysis. The concept of quality of life (QoL) was developed to satisfy this goal, and there are a variety of general health and QoL assessments tools available. The purpose of this study is to review the concept of health-related QoL and discuss health-related QoL measures as they relate to shoulder conditions.

Advances in the scientific understanding of health conditions and innovations in treatment over the past few decades have led to commensurate increases in healthcare costs, representing a substantial percentage of the GDP of most developed countries. Healthcare decision-makers seek to maximize patient outcomes by improving quality of life (QoL), while striking a balance with rising medical costs. This is especially relevant to orthopedic surgery which usually focuses on the treatment of painful and physically disabling conditions, often using costly technology and devices, as well as extensive perioperative care. Cost utility analyses are implemented to inform policy makers and decision-makers, ranging from the patient-physician interaction to government legislators. Quality-adjusted life years (QALYs), a key component of cost utility analysis, are derived from health-related quality of life (HRQoL) scores, wherein patients report their subjective preference for a state of health.[70] QALYs combine the quality and quantity of a patient's life after medical intervention into a composite value. QALYs and HRQoL data can be used to compare the cost-effectiveness and value of alternative treatment options of a specific condition, as well as to compare treatment of different conditions.

To maximize the utility of healthcare expenditure, decision-makers rely on data regarding the efficacy of medical interventions. In orthopedic surgery, data are derived from both objective and subjective assessments such as range of motion, strength, imaging findings, and patient-reported outcome assessments. Disease-specific or intervention-specific assessments, whether subjective or objective, may not permit comparison of different conditions or interventions. For example, the efficacies of a shoulder and knee surgery are difficult to compare because the outcome measures are fundamentally different. HRQoL measures, which are generic, can be used to satisfy the goal to compare utility between various conditions, as well as various interventions.

Shoulder pain is a common musculoskeletal complaint with reported lifetime prevalence as high as 66.7% and results in a substantial societal financial burden.[35] Rotator cuff disorders are the most common cause of shoulder pain and are often managed with rotator cuff repair (RCR) or shoulder arthroplasty.[33] An estimated 275,000 rotator cuff repairs are performed annually in the US.[10,47] Severe rotator cuff disorders, including rotator cuff arthropathy, are often managed with reverse shoulder arthroplasty (RSA).[31] An estimated 62,705 RSAs were performed in the US in 2017.[5] The utilization of RCR and shoulder arthroplasty is projected to substantially increase in the coming years.[5,10,49,72] Consequently, it is imperative that providers, administrators, and policy makers understand the relationship between cost and outcomes. The purpose of this study is to review the concept of HRQoL and to discuss relevant HRQoL measures as they relate to shoulder conditions.

Institutional review board approval was not required for this narrative review.

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https://doi.org/10.1016/j.jseint.2021.10.006

Patient-reported outcomes measures

Patient-reported outcome measures (PROMs) are self-assessments made independent of a physician or healthcare provider through the use of questionnaires that focus on general health status, QoL, pain, functional capability, and satisfaction. PROMs are thought to provide a more comprehensive and holistic assessment of a patient's status than traditional objective outcome measurements.[52] PROMs can be specific or generalized. Specific PROMs are applicable to symptoms and dysfunction caused by a disease process or attributable to body regions.[6,71] Disease-specific PROMs focus on a specific diagnosis, whereas region-specific PROMs assess a specific joint or body part regardless of the diagnosis or treatment modality. The various Western Ontario Outcome Scores are shoulder disease–specific PROMs, whereas the Simple Shoulder Test, American Shoulder and Elbow Surgeons score, Constant Score (CS), and Oxford Shoulder Score are examples of shoulder joint–specific PROMs. The Disability of Arm, Shoulder and Hand score is a region-specific PROM used for assessment of the upper extremity, including the shoulder. More generalized PROMs, such as the Short Form-36 (SF-36) and Veterans Rand-12 (VR-12), are designed to assess general health status reflecting multidimensional aspects of well-being, encompassing physical, social, and emotional aspects.[3]

The Patient-Reported Outcomes Measurement Information System (PROMIS), recently developed by the National Institutes of Health (NIH) of the United States Department of Health and Human Services, has received considerable attention. The original tool included 10 questions with the intention to be used across various anatomic regions and conditions. The PROMIS Physical Function (PROM-PF) subscore assesses social function, pain, fatigue, and emotional distress, whereas the PROMIS Global Health (PROM-GH) subscore assesses overall physical function, pain, fatigue, emotional distress, and social health. A computer adaptive format was developed to reduce the question burden. The PROM-PF assesses five categories of physical functioning which include the upper extremity, lower extremity, axial, central, and instrumental activities of daily living. Hung et al[25] reported that application of the PROM-PF to upper extremity disorders has limitations, with substantial ceiling effects.[25]

Shoulder-specific and upper extremity–specific PROMs do not address HRQoL and do not permit comparison of outcomes with nonshoulder conditions.[2,26,46] Similarly, general PROMs may not be sufficiently responsive to demonstrate the benefit from a shoulder-specific intervention.[51] Thus, to accurately characterize the effect treatment on shoulder procedures, most investigators and doctors advocate the use of both types of PROMs.[18]

Health-related quality of life scores

HRQoLs are generalized PROMs that assess a patient's perceived mental and physical state and can be used to determine health utility values. HRQoL measures are meant to be non–disease-specific instruments that can be universally applied to complement other measures of outcome.[15] HRQoL data have multiple clinically pertinent applications and can be used to evaluate the added value of a medical intervention or prevention to manage a given disease and compare treatment options to improve a state of health.[24,32,50] In addition, policy makers and payers can better appraise the utility of a medical intervention in the context of resource constraints, to optimize health.[37,64,70]

HRQoL instruments typically address multiple dimensions that reflect the relative weight of a health state. These scores are generated across multiple dimensions and are converted to a single index value that can be used for comparisons across a range of healthcare applications.[15] A formula specific to the measurement technique is used to derive a single index value. The resulting index value reflects how good or bad the health state is according to preferences of a reference general population.

Three different techniques including standard gamble (SG), time trade off (TTO), and rating scales are used to determine HRQoL scores, and these may yield different health states for the same individual.[64] Health preferences are influenced by a variety of factors including psychosocial and mental health issues that are not directly related to the physical condition. Consequently, evaluation of HRQoL of individuals with musculoskeletal conditions may not be directly relatable to the evaluation of individuals with non-musculoskeletal conditions, and this must be considered in any analysis.

Standard gamble

The SG technique asks patients to choose between living in their current health state and undergoing a treatment that has the potential to either restore them to perfect health or kill them. Consequently, the current health state of individuals who are more willing to accept a greater risk of death for the potential of a perfect health state is lower.[64]

The Short Form-6D (SF-6D) which is derived from the SF-36 is an SG HRQoL assessment. The SF-6D uses 11 questions from the SF-36 to assess six domains with four to six responses to yield 18,000 possible health states. The SF-6D domains are physical function, role limitation, social function, pain, mental health, and vitality. Brazier et al[7] determined the HRQoL values for the SF-6D from a survey of a representative cohort of 611 UK citizens, and the scores range from 0.291 to 1.000.

Time trade off

The TTO technique asks patients to choose living between X number of years in their current health state and Y number of years in perfect health.[64,67] The difference between X and Y reflects how many years the patient would be willing to "trade off" for perfect health. The TTO was first validated by a study of 246 randomly selected citizens of Ontario, Canada.[65] TTO may be simpler than the SG because the TTO asks the patient about their current state relative to perfect health, without considering the potential of death and may be more relevant to musculoskeletal conditions for which death is not a usual consideration.

The EuroQol 5 Dimensions (EQ-5D), developed by the EuroQoL group, is an example of a TTO assessment.[15] The EQ-5D consists of a questionnaire with descriptive responses and a visual analog scale (VAS). The original EQ-5D descriptive component assessed five domains (mobility, self-care, usual activities, pain/discomfort, and anxiety/depression), each with three possible responses (no problems, some problems, and extreme problems) to yield 243 ($=3^5$) health states.[15] The scores range from −0.59 to 1.00. Early use noted limited sensitivity to small changes and ceiling effects. This led to development of the EQ-5D-5L with five possible responses (no problems, slight problems, moderate problems, severe problems, and disabling problems) to increase sensitivity and reliability.[12,23] The EQ-5D is currently recommended by the United States Panel on Cost-Effectiveness in Health and Medicine[20] and the National Institute of Health and Clinical Excellence in Britain to determine cost-effectiveness.[40]

In comparison with the SF-6D, the EQ-5D may be more sensitive to utility gained in patients with a poor baseline, but not in patients whose preintervention values are at the upper end of the scale.[8,26,34] Bryan and Longworth[8] attributed these differences to the SF-6D having a greater number of domains (five vs. six) and levels (three vs. four to six), resulting in an increased response

range with increased discriminatory power. Similar conclusions were made with the increased number of levels in the EQ-5D-5L relative to the EQ-5D-3L.[12,23] Additionally, differences in the algorithms may yield different index scores for the same health state. For example, a patient who exists in a health state that they consider worse than death would have a negative value on the EQ-5D, while the lowest index value on the SF-6D is 0.291.[8]

Single-assessment rating scales

Single-assessment tools ask patients to define their current health state from 0 to 100, where 0 represents death and 100 represents perfect health.[64,66] The Rating Scales method is easier to implement than TTO and SG techniques because it does not require conversion of the response with a health state to determine the HRQoL score. The response burden on the patient is minimal because it requires a response to a single question.[4] Additionally, subjects may have different perceptions of "perfect health" or "death" due to conditions, such as congenital conditions or permanent disability that preclude a subjective experience of "perfect health" such that the absolute scores may not accurately reflect improvement as the change in scores.

VASs were first described by Hayes and Patterson[22] in psychology research and have since been widely validated in clinical applications, including the EuroQol visual analog scale (EQ-VAS) as an HRQoL instrument.[73] The EQ-VAS was intended to be used with the descriptive questionnaire portion of the EQ-5D. The EQ-VAS is a vertical VAS that the patient uses to provide a global assessment of their health. The scale is bounded by "best imaginable" and "worst imaginable" health state. Although easier to administer, the VAS differs from TTO and SG assessments. Nord questioned the content validity of the VAS used to value health states and recommended that VAS values should not be used directly as utility weights for life years requiring transformation of the values.[44]

Quality-adjusted life years

QALYs measure the burden of disease taking into account both the quantity and quality of life. HRQoLs are used to determine QALYs. One year of perfect health has a QALY value of 1 and death has a value of 0. Health states considered worse than death have a negative value. The number of QALYs associated with a given health state is determined by the product of the HRQoL and the number of years in that state. For example, intervention A might result in a QoL of 0.8 for 2 life-years, yielding 1.6 QALYs, whereas intervention B might result in a QoL of 0.6 for 4 life-years, yielding 2.4 QALYs. The net benefit of intervention B over intervention A would be 2.4 - 1.6 = 0.8 QALY. It is also important to recognize that over a period of time, there may be a sequence of health states as an individual transitions through differing health states to the end result that needs to be factored into a cost-effectiveness analysis.[38] Thus, QALYs offer a more comprehensive assessment than life-years gained or improved QoL.

Cost-effectiveness and value

The value of a medical intervention is expressed as a quotient of the improvement in health state and the financial cost. After measuring the QALYs associated with an intervention, incremental cost-effectiveness ratios (ICERs) can be calculated. The ICER is the quotient of difference in costs and the difference in effectiveness of two interventions. QALYs are typically used as the measure of effectiveness. Subsequently, relative cost-effectiveness is determined by comparing the calculated ICER with a willingness to pay (WTP) threshold, which is the price one will pay for one additional QALY. The traditional WTP threshold is set at $50,000/QALY based on a meta-analysis of studies on hemodialysis, peritoneal dialysis, and kidney transplantation in the United States.[75] More recently, some authors have suggested that $100,000/QALY is a more realistic cost-effectiveness threshold as many frequently used interventions fall in the $50,000–$100,000/QALY range.[68,69]

As stated earlier, it is not uncommon for different HRQoL instruments to yield differing scores, which raise concerns of their use to calculate QALYs and the comparability of studies.[57,74] Shiroiwa et al[60] reported that the SF-6D scores in the general Japanese population were significantly lower than EQ-5D scores. Obradovic et al[45] reported that mean EQ-5D scores were lower than mean SF-6D scores in patients with chronic pain and EQ-5D seemed to have higher construct validity and responsiveness in these patients. Gamst-Klaussen et al[17] found that the relationship between the SF-6D and EQ-5D is nonlinear and the utilities derived cannot be interchanged. Reports in orthopedic subspecialties further highlight significant differences between SF-6D and EQ-5D utility values.[41,59,76] Additionally, the reported minimal clinical important differences differ. These findings point to the need to be aware of the differences between various health utility instruments and that they cannot be used interchangeably. For example, Renfree et al[53] measured outcomes of RSA with the SF-6D and EQ-5D. They calculated $21,536/QALY by the SF-6D and $16,747/QALY by the EQ-5D. Future studies are needed to refine the administration of the HRQoL instruments to reconcile these disparities or delineate circumstances to clearly prefer one instrument over another.

Review of shoulder literature

There are only limited reports of investigation of health utility related to shoulder disorders. Overall, the EQ-5D is the most commonly used HRQoLs. Grobet et al[21] identified 19 studies in a systematic review of published studies of upper extremity surgery that reported EQ-5D values. Utility scores in nontrauma patients generally improved postoperatively, whereas trauma patients did not regain their recalled preinjury QoL levels. In contrast, numerous studies have focused on cost-effectiveness analysis. Of particular interest is that much of the reported results lack data specific to HRQoLs. Tischer et al[63] identified 34 studies in a systematic review that reported an economic analysis related to shoulder conditions. Nine of the 34 studies used their own HRQoL values, whereas the others derived them from published literature. They noted an improvement in the quality of studies in shoulder surgery, with most using either a Markov or decision analytic model and a WTP threshold of $50,000. These studies most commonly addressed various aspects of the treatment of rotator cuff tears (RCTs).[13,19,24,29,36,37] No studies compared treatment of different shoulder conditions or treatment of conditions involving other musculoskeletal regions.

Rotator cuff disease

HRQoL instruments have been utilized to evaluate RCR and RSA for treatment of RCTs. Karjalanien et al[30] performed a meta-analysis comparing subacromial decompression with placebo at one year. Both groups had similar pretreatment EQ-5D scores, and there was no difference in improvement (0.70 vs 0.73). Butt et al[9] used the EQ-5D to study the cost-utility of arthroscopic subacromial decompression and found improvement of 0.25 over fifteen months, which translated to a cost/QALY of £5683. Rombach et al[56] studied the cost-effectiveness of treatment of subacromial pain in a 3-armed placebo-controlled trial comparing arthroscopic decompression with arthroscopy only and no treatment. At one year follow-up, arthroscopic decompression resulted in improved EQ-

Table 1
Health-related quality of life data in reported shoulder literature.

Authors	Year	Condition	Number of subjects	Mean follow-up (range, if reported)	Treatment	HRQoL	Pretreatment HRQoL	Post-treatment HRQoL	Change	*P* value	Comments
Karjalaninen[30]	2019	Subacromial impingement	292	1 year	Placebo	EQ-5D	0.67	0.73	0.06	.06	
					Subacromial decompression	EQ-5D	0.66	0.70	0.04		
Butt[9]	2015	Subacromial impingement	83	15 months (4-27)	Subacromial decompression	EQ-5D	0.55	0.80	0.25	<.0001	
Rombach[56]	2019	Subacromial impingement	313	1 year	No treatment	EQ-5D-3L	0.50	0.66	0.16	NA	
					Subacromial decompression	EQ-5D-3L	0.52	0.74	0.22	.07	Compared with no treatment
					Arthroscopic debridement	EQ-5D-3L	0.55	0.73	0.18	.40	Compared with decompression
Nicholson[43]	2019	Rotator cuff tear	112	2 years	Rotator cuff repair <65 yo	EQ-5D	0.53	0.88	0.32	.70	
					Rotator cuff repair >65 yo	EQ-5D	0.57	0.90	0.33	.78	
Renfree[53]	2013	Rotator cuff tear	30	2.2 years (2.0-3.3)	RSA	EQ-5D	0.75	0.81	0.06	.04	
						SF-6D	0.59	0.66	0.07	<.003	
Nicholson[42]	2021	Rotator cuff arthropathy	67	2 years	Primary RSA	EQ-5D	0.34	0.78	0.44	.04	
					Revision RSA	EQ-5D	0.31	0.59	0.29		
Jain[26]	2020	Glenohumeral osteoarthritis	145	1 year	aTSA	EQ-5D	0.67	0.89	0.22	<.001	
						SF-6D	0.65	0.68	0.04	<.001	
						VAS QoL	57.20	11.50	−45.70	<.001	
Olerud[48]	2011	Proximal humerus fracture	165	1 year	Multiple	EQ-5D	0.86	Not reported	NA	NA	
Spross[62]	2019	Proximal humerus fracture	192	1 year	Conservative—algorithm adherent	EQ-5D	0.90	0.91	0.01	.12	
					Conservative—algorithm nonadherent	EQ-5D	0.86	0.85	−0.01		
					ORIF—algorithm adherent	EQ-5D	0.90	0.86	−0.04	.70	
					ORIF—algorithm nonadherent	EQ-5D	0.84	0.85	0.01		
					RSA—algorithm adherent	EQ-5D	0.80	0.87	0.07	.80	
					RSA—algorithm nonadherent	EQ-5D	1.00	0.89	−0.11		
Jonsson[28]	2020	Proximal humerus fracture	99	2.4 years	RSA	EQ-5D	0.93	0.84	−0.09	.72	
					Hemiarthroplasty	EQ-5D	0.86	0.82	−0.04		
Min[39]	2018	Shoulder instability	55	2 years	Arthroscopic Latarjet or Bankart	EQ-5D	0.79	0.93	0.14	.78	
Skare[61]	2017	SLAP tears	89	6 months	Surgical intervention—“improved”	EQ-5D	0.65	0.48	−0.17	Not reported	
						EQ-VAS	67.50	52.70	−14.80	Not reported	
					Surgical intervention—“unimproved”	EQ-5D	0.67	0.71	0.04	Not reported	
						EQ-VAS	70.60	76.20	5.60	Not reported	
Schrøder[58]	2014	SLAP tears	118	2 years	Sham surgery	EQ-5D	0.70	0.90	0.20	NA	
						EQ-VAS	66.70	76.80	10.10	NA	
					Biceps tenodesis	EQ-5D	0.60	0.80	0.20	.56	Compared to sham
						EQ-VAS	67.90	79.60	11.70	.49	Compared to sham
					Labral repair	EQ-5D	0.70	0.90	0.20	.93	Compared to sham
						EQ-VAS	68.40	81.70	13.30	.23	Compared to sham
Dattani[11]	2013	Adhesive capsulitis	100	6 months	ACR alone	EQ-5D	Not reported	Not reported	0.50	NA	
						EQ-VAS	Not reported	Not reported	13.30	NA	
					ACR/SD	EQ-5D	Not reported	Not reported	0.64	.08	Compared to ACR alone
						EQ-VAS	Not reported	Not reported	15.20	.66	Compared to ACR alone

(*continued on next page*)

Table 1 (*continued*)

Authors	Year	Condition	Number of subjects	Mean follow-up (range, if reported)	Treatment	HRQoL	Pretreatment HRQoL	Post-treatment HRQoL	Change	*P* value	Comments
Robinson[55]	2017	Adhesive capsulitis	41	1 year	Supervised physiotherapy	EQ-5D-3L	0.59	0.68	0.09	.06	
					Home exercises	EQ-5D-3L	0.65	0.88	0.24	.002	

HRQoL, health-related quality of life; *EQ-5D*, EuroQol 5 Dimensions; *RSA*, reverse shoulder arthroplasty; *SF-6D*, Short Form-6D; *aTSA*, anatomic total shoulder arthroplasty; *VAS QoL*, visual analog scale quality of life; *ORIF*, open reduction and internal fixation; *SLAP*, superior labral anterior posterior; *ACR*, arthroscopic capsular release; *ACR/SD*, arthroscopic capsular release with subacromial decompression.

5D-3L scores (from 0.517 to 0.735), but there was no difference compared with placebo surgery or no treatment (see Table I).

Nicholson et al[43] used the EQ-5D in a prospective study to determine the value of RCR in patients with massive RCTs. They found that arthroscopic RCR led to a mean improvement in the EQ-5D from 0.54 at baseline to 0.81 at one year ($P < .001$) and 0.86 at two years ($P = .08$). Patient age did not have a significant effect on the outcome, and they concluded that the EQ-5D scores reflected the excellent outcomes of RCR.

Renfree et al[53] studied the cost-utility of RSA to treat rotator cuff arthropathy in a prospective study based on QALYs calculated from EQ-5D and SF-6D outcome scores. The SF-6D improved from 0.59 to 0.66 ($P = .05$) at one year and 0.66 ($P = .03$) at two years. The EQ-5D improved from 0.75 to 0.81 ($P < .001$) at one year and 0.81 ($P = .04$) at two years. The calculated cost was $21,536/QALY by the SF-6D and $16,747/QALY by the EQ-5D. The authors suggested re-evaluating these calculations after ten years to account for complications or revision surgeries to determine if the QALY improvements are enduring.

Nicholson et al[42] studied cost-effectiveness comparing primary RSA and revision RSA from previous arthroplasty for rotator cuff arthropathy utilizing the EQ-5D. At 2 years postoperatively, primary RSA yielded a mean EQ-5D gain of 0.4409, whereas revision RSA yielded a mean EQ-5D gain of 0.2851 ($P = .040$). The calculated cost was £7596.76/QALY for primary RSA and £11,748.51/QALY for revision RSA.

Glenohumeral osteoarthritis

HRQoLs have been used in a limited number of studies assessing patients with glenohumeral osteoarthritis. Dowdle et al[14] sought to validate the PROMIS physical function computer adaptive test (PROM-PFCAT) and PROMIS Upper Extremity (PROM-UE) for anatomic Total shoulder arthroplasty (TSA) is an alternative to other PROMs, including the EQ-5D, in patients undergoing shoulder arthroplasty for glenohumeral arthritis. They found that the PROM-UE had moderate correlation with the EQ-5D ($r = .48$, $P < .002$) and the PROM-PFCAT demonstrated strong correlation with the EQ-5D ($r = .64$, $P < .001$). The authors did not specify whether they were evaluating anatomic TSA or RSA and did not report the actual EQ-5D values (see Table I).

Jain et al[26] compared the EQ-5D, SF-6D, and VAS-QoL to determine responsiveness and validity and correlation to specific PROMs, in patients with advanced glenohumeral osteoarthritis undergoing anatomic TSA. At one year after surgery, the EQ-5D improved from 0.667 to 0.887 ($P < .001$), the SF-6D improved from 0.647 to 0.682 ($P < .001$), and the VAS-QoL improved from 57.2 to 11.5 ($P < .001$). Additionally, based on the effect size relative to PROMs, the authors found that the VAS-QoL (1.843) had greater responsiveness than the EQ-5D (1.186) and SF-6D (1.083). They attributed the differences to differences in the instruments; the SF-6D emphasizes mental and psychological parameters, whereas the EQ-5D emphasizes more physical aspects.

Proximal humerus fracture

Olerud et al[48] validated the use of the EQ-5D in proximal humerus fractures (PHFs) by assessing the internal and external responsiveness in a study of 165 patients older than 55 years with a 3- or 4-part fracture resulting from a low-energy mechanism. Interestingly, the baseline EQ-5D score (0.86) was noted to be higher than in the United States population norm.[27] Post-treatment HRQoL scores were not reported. The internal responsiveness of the EQ-5D index score was considered "good" owing to the large absolute change in score (-0.209, $P < .001$) and standardized response mean of 0.9 (95% confidence interval = 0.74 - 1.06). Additionally, the receiver operating characteristic and logistic regression analyses demonstrated that the EQ-5D could discriminate between different degrees of improvement or deterioration (see Table I).

Spross et al[62] assessed the feasibility and early clinical outcome of an evidence-based treatment algorithm for isolated PHF as determined by the EQ-5D, CS, and Subjective Shoulder Value. They included nonsurgical, open reduction and internal fixation, hemiarthroplasty (HA), and RSA treatment. Patients treated according to the author's algorithm returned to pretreatment EQ-5D scores by 1 year. The pretreatment EQ-5D scores of all patients receiving conservative, open reduction and internal fixation, and HA intervention were 0.89, and that of the RSA group was 0.85, comparable with the findings of Olerud et al.[48] There were no differences in the EQ-5D values (range = 0.85 to 0.91) at one year for the algorithm-adherent group compared with the nonadherent groups. The authors ultimately endorsed their algorithm based on significantly greater CS improvements obtained by following their treatment algorithm.

Feissli et al[16] conducted a retrospective study to assess the efficacy of nonoperative compared with operative treatment to restore self-dependence in patients older than 65 years with AO type A2, A3, and B1 PHFs. The median EQ-5D score in the nonoperative group was 1.00 (median range = 0.47-1.00, n=17) was not significantly different than the operative group was 0.91 (median range = 0.40-1.00, n=22; $P = .556$). The authors concluded that nonoperative treatment is more likely to return a patient to preoperative functionality based on shoulder motion, strength, and functional outcome scores. Of note, only 41 of 147 initial patients were able to be interviewed for follow-up.

Jonsson et al[28] performed a multicenter randomized control trial of 3- and 4-part PHF managed with RSA or HA. The preinjury EQ-5D score was 0.92 in the RSA group and 0.90 in the HA group ($P = .72$). At one year and the final follow-up, there was no difference between the groups. The RSA EQ-5D was 0.87 at one year and 0.84 at the final follow-up, whereas the HA was 0.86 at one year and 0.82 at the final follow-up ($P = .017$). There were also no differences in the VAS pain and Western Ontario Outcome scores. Nevertheless, the authors concluded that RSA is superior to HA for 3- or 4-part PHFs based on the CS and better range of motion. In this study, the shoulder-specific outcome measures appeared to detect improvements that were not reflected in HRQoL, confirming the need to use HRQoL and specific PROMs.

Shoulder instability

Anthony et al[1] performed a prospective study comparing PROMIS instruments with other PROMs, including the EQ-5D, of patients undergoing operative treatment for shoulder instability. The PROM-UE had excellent to good correlation with the EQ-5D ($r = 0.66$, $P < .01$), and the PROM-PFCAT had excellent to good correlation with the EQ-5D ($r = 0.59$, $P < .01$). Derived EQ-5D data were not included in the study. Both the PROM-UE and PROM-PFCAT had excellent correlation with the SF-36 and American Shoulder and Elbow Surgeons score and good correlation with the Western Ontario Shoulder Instability Index (see Table I).

A cost-effectiveness study by Min et al[39] used Markov decision chain and Monte Carlo simulation to determine the ICERs of arthroscopic Bankart and open Latarjet, based on preoperative and 2-year postoperative EQ-5D data. The preoperative EQ-5D score was 0.794 and improved to 0.930 two years after either arthroscopic Bankart or Latarjet procedure. There was no significant difference between arthroscopic Bankart and Latarjet at the two-year follow-up ($P = .775$). The arthroscopic Bankart repair yielded a slightly more cost-effective ICER of $4214 than $4681 of the Latarjet procedure ($P < .001$), thought to be due to the lower utility state after a failed Latarjet.

Superior labral anterior posterior tears

Skare et al[61] evaluated the responsiveness of multiple instruments to outcome in a prospective study that compared arthroscopic labral repair, mini-open biceps tenodesis, and physical therapy with six-month follow-up. Patients were divided into subgroups based on subjective change in shoulder status: “improved” or “unimproved.” In the group that reported a subjective improvement, EQ-5D and EQ-VAS scores declined from 0.65 to 0.48 and 67.5 to 52.7, respectively. In the group that reported no subjective improvement, EQ-5D and EQ-VAS scores improved from 0.67 to 0.71 and 70.6 to 76.1, respectively. *P* values were not calculated for the change in EQ-5D scores. The authors concluded that distribution-based methods overestimate EQ-5D responsiveness, whereas anchor-based methods suggest the EQ-VAS is not responsive compared with shoulder-specific instruments because generic HRQoL outcomes are influenced more by general health and comorbidities than shoulder-specific outcomes (see Table I).

Schrøder et al[58] compared biceps tenodesis, labral repair, and sham surgery for isolated type 2 superior labral anterior posterior lesion in a prospective study. For the EQ-5D, the sham surgery improved from 0.6 at baseline to 0.9 at twenty-four months, biceps tenodesis improved from 0.7 to 0.8, and labral repair improved from 0.7 to 0.9. For the EQ-VAS, the sham surgery improved from 66.7 at baseline to 76.8 at twenty-four months, biceps tenodesis improved from 67.9 to 79.6, and labral repair improved from 68.4 to 81.7. Although biceps tenodesis was superior to sham surgery ($P = .03$) at three months, there was no difference at six-month follow-up ($P = .08$). The authors suggested that nonoperative management should be considered for younger patients with a type 2 superior labral anterior posterior lesion, but further study is needed to establish optimal treatment.

Adhesive capsulitis

Dattani et al[11] reported the results of a prospective, nonrandomized study of cost-effectiveness for treatment of adhesive capsulitis that failed nonoperative treatment. They compared arthroscopic capsular release (ACR) with ACR with subacromial decompression (ASD). Arthroscopic release led to significant improvement in the EQ-5D and EQ-5D-VAS at a median follow-up of six months. However, there was no significant difference in the outcomes between ACR alone vs ACR + ASD. The median EQ-5D improvement of ACR alone was 0.5 at £2563/QALY, and the median EQ-5D improvement of ACR + ASD was 0.64, at £3189/QALY (see Table I).

Robinson et al[55] performed a randomized controlled trial that compared supervised physiotherapy with home exercise program for patients who had hydrodilation to treat adhesive capsulitis. At one year after procedure, patients who had supervised physiotherapy had improvement in the EQ-5D scores from 0.591 to 0.684 ($P = .0577$), whereas the patients who had home exercise program had improvement from 0.645 to 0.882 at one year ($P = .0017$). However, there was no significant difference when comparing the two interventions at any time point.

Future research

The recent interest in health utility and cost-effectiveness analysis, combined with the increasing use of big data analysis, has resulted in work focused on the development of HRQoL tools that can be readily applied across specialties and conditions. Over the past few years, there has been a great deal of work using the PROMIS for the assessment of shoulder conditions.[1,14,17,25,54] Several studies of various shoulder conditions and surgical procedures report variable correlation between the PROMIS and commonly used shoulder PROMs. It appears that most authors conclude that the PROMIS cannot be used in place of shoulder PROMs. This does not necessarily mean that PROMIS does not have utility for assessing patients with shoulder conditions. To date, there are no studies that equate PROMIS scores to health utility in shoulder conditions. Revicki et al[54] studied a sample of 20,400 US citizens and reported that the PROMIS can be used to determine the EQ-5D. Because the PROMIS is a generalized tool and given the fact that the PROMIS has been widely accepted in the United States, further study will likely lead to the PROMIS having an important role in health utility and cost-effectiveness analysis of musculoskeletal conditions, including the shoulder.

Summary

The increasing cost of healthcare in the U.S. and globally, and restricted resource availability creates difficult resource allocation dilemmas. Decision-makers are tasked with maximizing the utility of these resources to improve societal QoL. HRQoL scores assess multiple aspects of health states. Patient preferences are determined with HRQoL instruments, such as the SF-6D, EQ-5D, and VAS, and utilized to calculate QALYs to enable comparison of interventions. Because the differing underlying techniques of these instruments limit their direct comparability, future study is needed to refine the appropriate usage of these tools for the assessment of shoulder conditions as HRQoL instruments will be increasingly utilized in orthopedic shoulder research to determine cost-effectiveness and value to justify allocation of healthcare expenditure and resources.

Disclaimers:

Funding: No funding was disclosed by the authors.
Conflicts of interest: The authors, their immediate families, and any research foundation with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

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