http://dx.doi.org/10.2106/JBJS.M.00372

TABLE E-1 Outlines of the HRQOL Scoring Systems

System	Components
WOMAC[18]	24 items measuring three subscales. Higher scores indicate worse outcome. Pain: during walking, stairs, bed, sitting, lying, standing Stiffness: after waking and later in the day Physical function: stairs, rising from sitting, standing, bending, walking, shopping, putting on socks, bathing, toilet, household duties
KSS[21]	6 domains. Higher scores indicate better outcome. Objective knee indicators: alignment, instability, joint motion Symptoms: functional pain Patient satisfaction: functional outcome Patient expectations: activities of daily living Functional activities: walking, standing Discretionary knee activities: recreational, gym
OKS[19]	12 items assessing pain and physical limitation. Higher scores indicate better outcome.
KSCR[22]	19 items assessing 2 domains. Higher scores indicate better outcome. Knee score: pain, range of motion, stability, deductions Function: walking, stairs, assistance
AKSS[22]	12 items assessing physical and psychological domains. Higher scores indicate better outcome. Knee score: pain, stability, range of motion Function: walking distance, stair climbing
ISK[23]	43 items assessing 3 domains. Higher scores indicate worse outcomes. Pain or discomfort: during rest, motion, standing, walking, rising Maximum distance walked: distance, walking aids Activities of daily living: stairs, bending, uneven ground
VAS[20]	10-cm horizontal line marked 0 to 100. Higher scores indicate worse pain.
KOOS[24]	42 items assessing 6 domains. Higher scores indicate better outcome. Symptoms: range of motion, swelling, grinding, catching Stiffness: after waking, later in day Pain: frequency, triggers, time Function, daily living: stairs, sitting, standing, bed, putting on socks, toilet, domestic duties Function, sports recreation: squatting, running, jumping, twisting, kneeling Quality of life: awareness, functional impact
SF-36[25,26], SF-12[27]	36 or 12 items measuring 8 conceptual domains or dimensions of health. Higher scores indicate better outcome. General health (GH): measures perceived overall health, including past and present health Physical functioning (PF): indicates level of limitations in lifting, bending, kneeling, or walking moderate distance Bodily pain (BP): represents the intensity, frequency, and duration of bodily pain and limitations in normal activities due to pain Mental health (MH): measures the emotional, cognitive, and intellectual status of the patient Role physical (RP): measures the degree to which patients can perform the usual activities for their age and social status Role emotional (RE): measures personal feeling of job performance at work or other activities Vitality (VT): measures feeling of energy, fatigue, and tiredness Social functioning (SF): indicates ability to develop and maintain mature social relationships Note: both the SF-36 and SF-12 can also provide two summary measures, the physical component summary (PCS) and mental component summary (MCS)

continued

http://dx.doi.org/10.2106/JBJS.M.00372

TABLE E-1 (*continued*)

System	Components
NHP[28]	38 yes/no statements on health problems covering 6 dimensions of subjective health. Higher scores indicate worse outcome. Physical mobility: only walk indoors, difficult to bend, unable to walk, trouble with stairs, difficult to reach for things, difficult to dress, hard to stand for long times, needs help walking outside Pain: pain at night, unbearable pain, pain on movement, pain on walking, pain on standing, constant pain, pain with stairs, pain on sitting Sleep: require sleeping tablets, early morning wakening, awake most of the night, takes a long time to get to sleep, insomnia Energy level: tiredness, everything is an effort, easily run out of energy Emotional reactions: feeling down, anhedonia, feeling on edge, day seems to drag, easily lose temper, feel like losing control, ruminating at night, feel like life is not worth living, wake up feeling depressed Social isolation: feel lonely, difficult to make contact with people, feel close to no one, feel like a burden to people, difficulty interacting with people

http://dx.doi.org/10.2106/JBJS.M.00372

TABLE E-2 Detailed Results of the Included Studies*

Study	Objective, HRQOL Measures, and Results	Follow-up Interval	Conclusions
Bullens[34], 2001	Objective: to determine whether a significant correlation between subjective and objective outcomes is present in patients after TKR Disease-specific measures: WOMAC, postop.: pain 78.4 ± 20.7, stiffness 68.4 ± 24.7, PF 62.9 ± 24.5, total 69.9 ± 20.5 KSS, postop. vs. preop.: total score (83.5 ± 12.9 vs. 32.9 ± 16.3) and function (51.5 ± 28.0 vs. 29.1 ± 18.0) improved VAS, postop.: pain 12 ± 18, satisfaction 80 ± 28 Generic instruments: NR Function: NR	Mean, 4.9 ± 0.9 yr	Substantial improvements in disease-specific HRQOL measures. Patients and surgeons have different criteria for satisfactory outcome after TKR. Surgeons may be more satisfied than patients
Joshi[35], 2002	Objective: to evaluate results of TKR in nonagenarians Disease-specific measures: KSS, postop. vs. preop.: mean knee score 95 (range, 84-100) vs. 45 (range, 27-59); mean function score 53 (range, 0-80) vs. 28 (range, 0-60); $p < 0.001$ for both Generic instruments: NR Function: Range of motion: mean range of motion increased from 107° (range, 85°-120°) preop. to 113° (range, 85°-135°)	Mean, 5.2 yr (range, 0.1-12.7 yr)	Excellent improvements in disease-specific HRQOL measures with only moderate functional improvement. Improved ability to handle ADLs and improving HRQOL. Increased mortality and morbidity with fewer years of life remaining should be considered prior to TKR in this age group
Pagnano[36], 2004	Objective: to assess results of primary and revision TKR in patients ≥90 yr of age, with particular attention to perioperative medical morbidity, mortality, and rate of complications Disease-specific measures: KSS, postop. vs. preop.: pain (86 vs. 30, $p < 0.01$) and function (38 vs. 29, $p < 0.01$) scores improved significantly Generic instruments: NR Function: Patient satisfaction was high, with all except for 1 patient satisfied with the outcome of surgery. 76% of patients were able to walk with no limp or a slight limp at last follow-up. In contrast, 71% of patients walked with a marked limp or were unable to walk before the TKR	Mean, 3.9 yr	Disease-specific HRQOL improved. Substantial relief of pain and maintained functional improvements. Primary or revision TKR is reliable, durable, and relatively safe for patients ≥90 yr of age. Medical and surgical complications are more common but do not compromise the ultimate outcome of surgery. Patients ≥90 yr of age survived >5 yr after TKR
Wright[37], 2004	Objective: to investigate 10-yr survival, predictors of mortality, and functional status compared with an age and sex-matched normal population	Mean, 11.7 ± 0.9 yr	Disease-specific HRQOL improves markedly. An almost normal generic HRQOL status can be maintained after primary TKR.

continued

http://dx.doi.org/10.2106/JBJS.M.00372

TABLE E-2 (*continued*)

Study	Objective, HRQOL Measures, and Results	Follow-up Interval	Conclusions
	Disease-specific measures: WOMAC, postop.: pain 87.9 ± 17.4, function 79.0 ± 20.2 Generic instruments: SF-36, postop.: GH 64.5 ± 20.4, PF 42.9 ± 29.1, RP 38.0 ± 43.5, BP 60.2 ± 26.1, VT 50.3 ± 19.8, SF 74.9 ± 27.1, RE 65.6 ± 44.5, MH 76.0 ± 16.1 Function: 75% patients were very satisfied with the overall results of TKR. 4% of patients remained confined to a bed or wheelchair, 37% were still very active and able to do heavy housework and participate in moderate sports activities, 46% were able to walk unaided, and 13% only used a cane when walking long distances		Patients whose general health was good enough for them to survive for more than 10 yr after primary total knee arthroplasty have excellent HRQOL and are very pleased to have had the procedure
Alfonso[38], 2007	Objective: to review experience with total joint arthroplasty in patients ≥90 yr of age for the purpose of determining what measures can be taken to make total joint arthroplasty in this age group safer Disease-specific measures: KSS, postop. vs. preop.: clinical score 93 vs. 41, function 42 vs. 27 Generic instruments: NR Function: NR	Mean, 4.1 yr (range, 1.8-8.1 yr)	Disease-specific HRQOL improves markedly. When considering joint arthroplasty in the nonagenarian, it is important for the surgeon and patient to be aware of the medical complications that can arise
Bourne[39], 2007	Objective: to determine whether or not patient factors (particularly sex, age, diagnosis, and obesity) influence TKR outcomes Disease-specific measures, change from preop. to postop.: KSCR knee: female 47 ± 20, male 51 ± 19 (p = 0.17) KSCR function: female 21 ± 24, male 25 ± 22 (p = 0.01) WOMAC: female 26 ± 23, male 24 ± 22 (p = 0.028) Generic instruments, change from preop. to postop.: SF-12 MCS: female 0.49 ± 12, male −1.27 ± 11 (p = 0.51) SF-12 PCS: female 7 ± 11, male 8 ± 11 (p = 0.12) Function, change from preop. to postop.: Range of motion: female 5° ± 17°, male 4° ± 16° (p = 0.29)	Mean, 9.5 yr (range, 5-11 yr)	Disease-specific and generic HRQOL measures improve. Contemporary TKR functions well at ≥10 yr of follow-up. All patient groups achieve important benefits from TKR and similar change scores, regardless of sex, age, diagnosis, or obesity class

continued

http://dx.doi.org/10.2106/JBJS.M.00372

TABLE E-2 (*continued*)

Study	Objective, HRQOL Measures, and Results	Follow-up Interval	Conclusions
Brander[40], 2007	Objective: to investigate if the influence of psychosocial factors on outcome is strong enough to warrant intervention, and if there are any practical diagnostic or treatment interventions that might mitigate the influence of these psychological problems Disease-specific measures: KSS, postop. vs. preop.: total 161.9 ± 67 vs. 90.6 ± 29, pain 87 ± 12.97 vs. 45.8 ± 15.9, function 76 ± 24 vs. 45 ± 19.6 VAS: preop. 53, 1-mo 36, 3-mo 36, 6-mo 17, 12-mo 13, 5-yr 11 Generic instruments: NR Function: Nearly all patients who originally had substantial knee pain were satisfied with outcomes at 5 yr	1, 3, 6, and 12 mo and 5 yr	Disease-specific HRQOL improves markedly. Strong association between depressive symptoms and long-term pain and lower function after TKR
Núñez[41], 2007	Objective: to evaluate HRQOL in patients with severe OA undergoing TKR and to identify the influence of sociodemographic, clinical, intraoperative, and postop. variables on HRQOL at 36 mo after TKR Disease-specific measures: WOMAC, 3 yr postop. vs. preop.: pain (23.21 ± 17.57 vs 50.57 ± 12.73, $p < 0.001$), stiffness (18.89 ± 20.31 vs. 31.84 ± 23.32, $p = 0.005$), and function (34.59 ± 17.90 vs 54.31 ± 16.28, $p < 0.005$) all had significant improvements Generic instruments: NR Function: NR	3 yr	Significant improvements in disease-specific HRQOL at 36 mo after TKR. Lower preop. WOMAC scores, chronic pain unrelated to knee OA, and severe obesity negatively influence postop. WOMAC scores
Busija[26], 2008	Objective: to assess the utility of SF-36 subscales in orthopaedics by examining the magnitude and meaningfulness of change and sensitivity of SF-36 scores in orthopaedic surgery Disease-specific measures: NR Generic instruments: SF-36, postop. vs. preop.: PF (52.3 ± 24.1 vs. 30.0 ± 14.9), RP (48.0 ± 43.9 vs. 12.6 ± 23.7), BP (63.9 ± 25.1 vs. 30.6 ± 18.8), VT (61.0 ± 27.7 vs. 50.3 ± 26.7), SF (83.5 ± 25.2 vs. 72.7 ± 23.0), RE (57.7 ± 42.4 vs. 40.5 ± 43.0), and MH (77.2 ± 20.1 vs. 71.0 ± 21.0) improved. GH (62.7 ± 24.0 vs. 66.0 ± 18.3) was worse. Function: NR	6 mo and 1 and 5 yr	Generic HRQOL improves in almost all domains. SF-36 can be used to show changes for groups in physical, mental, and social dimensions and for comparison with population norms

continued

http://dx.doi.org/10.2106/JBJS.M.00372

TABLE E-2 (*continued*)

Study	Objective, HRQOL Measures, and Results	Follow-up Interval	Conclusions
Chana[42], 2008	Objective: to evaluate the clinical outcome of the uncemented Duracon TKR system Disease-specific measures: KSS, 5 yr postop. vs. preop.: total 77.1 vs. 43.8, function 63.4 vs. 20.3 WOMAC, 5 yr postop. vs. preop.: the sum of function (588 vs. 919), pain (157 vs. 266), and stiffness (56 vs. 124) scores improved Generic instruments: SF-12, 5 yr postop. vs. preop.: total −17.7 vs. −24.4 Function: NR	3 mo and 1, 2, 5, 6, 7, and 8 yr	Disease-specific and generic HRQOL instruments show marked improvements. Strong evidence of the benefits of the Duracon prosthetic design, leading to a low complication rate
Cushnaghan[3], 2009	Objective: to assess long-term outcome and predictors of prognosis following TKR for OA Disease-specific measures: NR Generic instruments: SF-36: scores for VT and MH subscales were comparable with controls, with a slight decrease in VT and a slight increase in MH ($p < 0.001$). The scores for the PF subscale were markedly lower than normative values but higher at the time of follow-up than at preop., whereas scores for controls decreased substantially. The difference in change from preop. among the patients as compared with controls was highly significant ($p < 0.001$) Function: NR	Mean, 6.9 yr (range, 5.4-7.9 yr)	Improvements in physical function following TKR for OA are sustained. Benefits extend to patients with BMI >30 kg/m^2. Provided appropriate selection criteria are applied, no justification for withholding TKR from patients who are obese
Hudd[43], 2009	Objective: to report intermediate-term follow-up of the Rotaglide TKR using a concise reporting format that allows comparison with future long-term studies Disease-specific measures: AKSS, 5-yr 164.1, 6-yr 158.3, 7-yr 159.3, 8-yr 153.6 OKS: 5-yr 19.9, 6-yr 20.7, 7-yr 21.8, 8-yr 23.1 WOMAC: 5-yr 11.8, 6-yr 11.4, 7-yr 11.0, 8-yr 16.5 Generic instruments: NR Function: NR	Mean, 6.6 yr (range, 5-8 yr)	RTK compares favorably with other TKRs at intermediate-term follow-up. Survival of 99% with no revisions for aseptic loosening; good to excellent outcomes at 5-8 yr
Nilsdotter[24], 2009	Objective: to investigate predictors of postop. outcome and extent of physical activity in patients 5 yr after TKR	6 mo and 1 and 5 yr	Significant improvements in disease-specific and generic HRQOL. Best results at 1 yr and declines from 1 to 5 yr after TKR.

continued

http://dx.doi.org/10.2106/JBJS.M.00372

TABLE E-2 (*continued*)

Study	Objective, HRQOL Measures, and Results	Follow-up Interval	Conclusions
	Disease-specific measures: KOOS: at the 6-mo follow-up, the patients had improved in all 5 subscales of the KOOS ($p < 0.001$). At 12 mo, they had improved further in all subscales except sport/rec ($p < 0.001$). At the 5-yr follow-up, a deterioration was seen in the ADL subscale compared with the 12-mo follow-up ($p < 0.001$) Generic instruments: SF-36: At the 6-mo follow-up, the patients had improved in all subscales ($p < 0.001$) except GH. At 12 mo, no further significant improvements were reported. At the 5-yr follow-up, deteriorations were seen in the BP, PF, and VT subscales compared with the 12-mo follow-up ($p < 0.01$). Function: NR		Older age predictive of more pain and other postop. symptoms. No predictors of postop. PF identified
Núñez[44], 2009	Objective: to evaluate HRQOL in patients with severe OA undergoing TKR; to identify the influence of sociodemographic, clinical, intraoperative, and postop. variables on HRQOL; and to determine patient perceptions of TKR at 7 yr Disease-specific measures: WOMAC, 7 yr postop. vs. preop.: improvement was shown in total (33.3 ± 21.3 vs. 54.2 ± 16.3), pain (25.9 ± 21.5 vs. 52.9 ± 16.3), stiffness (25.9 ± 25.5 vs. 43.3 ± 26.6), and function (36.4 ± 21.3 vs. 54.2 ± 16.0) scores; $p < 0.001$ for all domains Generic instruments: SF-36 for men vs. women, 7 yr postop.: PF 55.1 ± 27.1 vs. 39.5 ± 22.9, RP 71.2 ± 36.5 vs. 51.5 ± 42.7, BP 66.2 ± 26 vs. 55.6 ± 28.9, GH 60.7 ± 17.1 vs. 50.7 ± 21.2 Function: 76.8% of patients were very satisfied or satisfied with the surgery. 79.5% of patients would be willing to undergo the operation again. 56% of patients did regular physical activity at 7 yr	Mean, 7 yr	Disease-specific HRQOL improves. Female sex, severe obesity, and complications after surgery negatively influence health outcomes measured by the WOMAC
Gandhi[45], 2010	Objective: to use longitudinal regression modeling to identify the patient-level predictors for a sustained functional outcome following TKR for OA at a minimum of 1 yr of follow-up	Mean, 3.0 yr (range, 1-8 yr)	HRQOL is better than preop. for up to 3-4 yr. After this, HRQOL declines up to 8 yr. HRQOL remains superior to preop.

continued

http://dx.doi.org/10.2106/JBJS.M.00372

TABLE E-2 (*continued*)

Study	Objective, HRQOL Measures, and Results	Follow-up Interval	Conclusions
	Disease-specific measures: WOMAC: declined from >50 to 25 and remained steady over 8 yr. Longitudinal regression showed than an older age, female sex, years of follow-up, and a poorer mental health state were predictive of a less sustained functional outcome Generic instruments: SF-36: PF increased from 25 to >45 and declined back to 35 at 8 yr. RP increased from 23 to 53 and declined back to 43 at 8 yr. Greater age, greater comorbidity, less education, and a poorer mental health state predicted a less sustained functional outcome. Function: NR		Older age, years of follow-up, greater comorbidity, and a poorer mental health state are identified as negative prognostic factors for a sustained functional outcome following TKR
Rat[46], 2010	Objective: to compare HRQOL scores 3 and 10 yr after TKR for OA with age and sex-adjusted HRQOL scores in a general population, and to determine factors associated with HRQOL after surgery Disease-specific measures: ISK, 3 and 10-yr cohorts: 50.6 ± 13.3 and 46.4 ± 14.2 (p = 0.22) Generic instruments: SF-36, 3 yr: PF 37.1 ± 22.2, MH 55.3 ± 19.3, BP 34.0 ± 15.3, SF 62.7 ± 23.2 NHP: physical abilities 48.8 ± 20.8, emotional reaction 73.9 ± 27.8, pain 29.1 ± 25.9, social isolation 83.7 ± 25.1 at 10 yr Function: Walking distance, 3 and 10 yr: 1928 ± 2180 m and 1346 ± 1489 m	3 and 10 yr	Impaired HRQOL compared with preop. persists over time despite substantial improvement in condition. Comorbidities, environmental factors, and the presence of painful locations other than the total knee replacement location are the main factors associated with postop. HRQOL. Preop. HRQOL is predictive of HRQOL at 3 yr but not 10 yr after surgery
Seng[47], 2011	Objective: to investigate the effect of conventional and high-flexion TKR on range of motion, HRQOL, and functional outcome Disease-specific measures: OKS: improved postop. for both the high-flexion and conventional groups all of the way to the 5-yr follow-up, with no significant difference between the scores in these groups KSS, postop. vs. preop.: conventional group function (62 vs. 48) and knee (87 vs. 42) and high-flexion group function (69 vs. 48) and knee (84 vs. 42) scores improved to 5 yr	6 mo and 2 and 5 yr	Disease-specific HRQOL improves. Generic HRQOL equal to or better than preop. High-flexion implants produce a sustainable and consistently higher angle of knee flexion after TKR, suitable for patients requiring greater functional flexibility

continued

http://dx.doi.org/10.2106/JBJS.M.00372

TABLE E-2 (*continued*)

Study	Objective, HRQOL Measures, and Results	Follow-up Interval	Conclusions
	Generic instruments: SF-36, postop. vs. preop.: conventional group PF (53 vs. 37) and MCS (44 vs. 38) and high-flexion group PF (63 vs. 37), MH (79 vs. 69), MCS (47 vs. 38), and PCS (57 vs. 48) improved. Conventional group PCS (51 vs. 51) was the same. Conventional group GH (62 vs. 77) was worse Function: Decreased flexion angle in conventional group. Increased flexion angle in high-flexion group		
Bruyère[13], 2012	Objective: to assess HRQOL in a prospective study with 7 yr of follow-up in 49 consecutive patients who underwent TKR because of OA Disease-specific measures: WOMAC, 7 yr postop. vs preop.: pain (2.8 ± 3.6 vs. 9.9 ± 3.6, p = 0.0001), stiffness (1.5 ± 1.7 vs. 3.0 ± 4.2, p = 0.02), and function (14.4 ± 13.7 vs. 31.1 ± 15.1, p = 0.0001) improved significantly Generic instruments: SF-36, 7 yr postop. vs. preop.: PF (67 ± 28 vs. 45 ± 21, p = 0.001), BP (67 ± 28 vs. 37 ± 25, p = 0.0001), SF (79 ± 18 vs. 68 ± 26, p = 0.08), RP (86 ± 28 vs. 34 ± 31, p = 0.0001), and RE (85 ± 32 vs. 59 ± 40, p = 0.02) improved. MH (65 ± 18 vs. 65 ± 23, p = 0.79) and VT (57 ± 14 vs. 57 ± 25, p = 0.81) were similar. GH (60 ± 15 vs. 72 ± 17, p = 0.0008) was worse Function: NR	3 and 6 mo and 7 yr	Disease-specific HRQOL improves significantly. Some dimensions of generic HRQOL are improved over short-term follow-up after TKR and these improvements are maintained up to 7 yr after surgery. Not all dimensions of HRQOL get better and no significant changes in utility values were observed over the long-term
Meding[48], 2012	Objective: to determine whether pain relief and function diminish 20 yr after TKR Disease-specific measures: KSS: improved over time. Preop. 54 ± 11, 1-yr 80 ± 13, 10-yr 88 ± 9, 15-yr 86 ± 9, 20-yr 85 ± 11 (p = 0.0075) KSS pain: did not diminish over time. Preop. 30 ± 10, 1-yr 48 ± 6, 10-yr 49 ± 5, 15-yr 39 ± 10, 20-yr 37 ± 12 (p > 0.05) KS function: scores increased then diminished over time. Preop. 36 ± 20, 1-yr 69 ± 24, 10-yr 86 ± 15, 15-yr 83 ± 18, 20-yr 75 ± 25 (p = 0.0005) Generic instruments: NR	Mean, 21.1 ± 1.6 yr	Disease-specific HRQOL improves postop. but may diminish over time. Aging may cause a gradual decline in physical activity after TKR, but improved functional outcomes continue over the long term

continued

http://dx.doi.org/10.2106/JBJS.M.00372

TABLE E-2 (*continued*)

Study	Objective, HRQOL Measures, and Results	Follow-up Interval	Conclusions
	Function: Walking: preop. 21 ± 10, 1-yr 47 ± 9, 10-yr 48 ± 7, 15-yr 45 ± 11, 20-yr 40 ± 14 (p = 0.741) Stairs: preop. 30 ± 11, 1-yr 37 ± 10, 10-yr 41 ± 9, 15-yr 39 ± 10, 20-yr 37 ± 12 (p < 0.0001)		

*TKR = total knee replacement, PF = physical functioning, NR = not recorded, ADLs = activities of daily living, GH = general health, RP = role physical, BP = bodily pain, VT = vitality, SF = social functioning, RE = role emotional, MH = mental health, OA = osteoarthritis, BMI = body mass index, and RTK = Rotaglide mobile-bearing TKR.