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Quality of Care and Patient-reported Outcomes in Carpal Tunnel Syndrome: A Prospective Observational Study

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Abstract

Introduction: Higher quality care for carpal tunnel syndrome (CTS) may be associated with better outcomes.

Methods—This prospective observational study recruited adults diagnosed with CTS from 30 occupational health centers, evaluated physicians' adherence to recommended care processes, and assessed the Boston Carpal Tunnel Questionnaire (BCTQ) and Short Form Health Survey version 2 (SF-12v2) at recruitment and 18 months.

Results: Among 343 individuals, receiving better care (80th vs. 20th percentile for adherence) was associated with larger improvements in BCTQ Symptom Severity scores (−0.18, 95% CI −0.32 to −0.05), BCTQ Functional Status scores (−0.21, 95% CI −0.34 to −0.08), and SF12-v2 Physical Component scores (+1.75, 95% CI 0.33 to 3.16). Symptoms improved more when physicians assessed and managed activity, patients underwent necessary surgery, and employers adjusted job tasks.

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Ethical Publication Statement: We confirm that we have read the Journal's position on issues involved in ethical publication and affirm that this report is consistent with those guidelines.

Discussion: Efforts should be made to ensure that patients with CTS receive essential care processes including necessary surgery and activity assessment and management.

Keywords

quality of care; occupational diseases; carpal tunnel syndrome; outcomes; functional status

Introduction

Improving the quality of healthcare has become a national priority, and assessing adherence to recommended care processes is fundamental to many improvement efforts. Yet the relationship between care processes and clinical outcomes is often uncertain.¹ For cardiovascular diseases, several studies have demonstrated associations between adherence to recommended care processes and clinical outcomes.^{2–4} Few studies have examined the role that quality of care plays in the outcomes of musculoskeletal conditions.

Quality of care has particularly important implications for carpal tunnel syndrome (CTS), which affects 3–4.7% of employed adults.⁵ Better care may affect not only symptoms but also the ability to function—and potentially to work.⁶ Clinicians attribute CTS to work in 67–74% of patients.⁵ Furthermore, work-associated CTS leads to sizeable medical and disability costs.⁷

In this prospective observational study, we tested the pre-specified hypothesis that better care for CTS is associated with greater improvements in symptoms, functional status, and overall health. Secondary objectives included identifying aspects of care and job factors that are associated with these outcomes.

Materials and Methods

In collaboration with Kaiser Permanente Northern California (KPNC) Regional Occupational Health, we recruited adults who had a workers' compensation claim for CTS and reviewed medical records to evaluate quality of care, meaning adherence to measures for underuse and overuse, during the year after recruitment. Underuse was defined as not providing necessary care, meaning care for which potential benefits greatly exceed risks. Overuse was defined as providing inappropriate care, meaning for which risks exceed potential benefits.^{8,9} We observed changes in patient-reported outcomes from baseline to follow-up at 18 months, and then compared these changes between patients who received better vs. worse care. We followed the STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) Statement.¹⁰

Data Sources

To identify potential subjects, KPNC Regional Occupational Health used internal workers' compensation databases. To evaluate quality of care, we reviewed electronic medical records. To assess outcomes, survey researchers interviewed subjects by telephone at baseline (August 2011 to March 2013) and follow-up (May 2013 to October 2014).^{11,12}

Participants

Specialists in 30 KPNC Occupational Health Centers treat 45,000 individuals with workers' compensation claims annually. From this population, KPNC Regional Occupational Health identified adults ages 18 and above who had a diagnosis of CTS (ICD-9 code 354.0 or 354.1) that was newly linked to a workers' compensation claim. We included patients who had atypical presentations, lacked electrodiagnostic confirmation, were eventually found not to have CTS, or were no longer covered under a workers' compensation claim because diagnostic uncertainty is common in CTS and, in our prior work, it was associated with receiving lower quality of care.¹² Also, several quality measures addressed the diagnostic evaluation, and having a higher quality evaluation may be associated with more timely treatment and better outcomes. To be included in the present analysis, subjects had to complete surveys at baseline and follow-up, not have CTS from an acute injury, and be eligible for at least 1 underuse and 1 overuse measure. Institutional Human Subjects' Protections Committees approved the study.

Quality of Care

The analysis had two main independent variables to evaluate quality of care, aggregate *underuse* and *overuse* scores. To construct these variables, we applied 45 quality measures including 10 measures of underuse and 15 measures of overuse. In total, 11 measures addressed care processes related to evaluation and monitoring, 11 addressed non-operative treatment, 10 addressed activity assessment and management, and 13 addressed surgical appropriateness (divided into situations where surgery was considered necessary, inappropriate, or of uncertain appropriateness). Four measures were specific to work-associated CTS.

Each quality measure had detailed criteria for identifying eligible patients (a denominator) and assessing whether care adhered to the measure (a numerator).^{13–17} Measures assessed clinical care based on what physicians knew and documented at the time. For example, one measure asks: if a physician documented a new diagnosis of CTS, was a detailed occupational history performed?

Three professional abstractors reviewed documentation from CTS-related visits occurring within 3 months before to 12 months after recruitment. If subjects had bilateral claims for CTS, data collection focused on the dominant hand to avoid counting the same care twice.

During analysis, we ascertained eligibility for and adherence to individual quality measures and then derived patient-level aggregate *underuse* and *overuse* scores (higher scores reflect better quality). For secondary analyses, we derived aggregate underuse scores for evaluation and monitoring, non-operative treatment, and activity assessment and management. Scores were derived using two steps. First, because individuals were eligible for different measures and adherence varied across measures, we subtracted the measure's mean adherence rate from the patient's score to standardize the score for each patient and measure. Next, we averaged standardized scores across measures for which the patient was eligible.

We coded surgery as necessary, inappropriate, or of uncertain appropriateness based on the most severe symptoms, signs, and electrodiagnostic test results documented. Adherence

meant receiving surgery when necessary, and not undergoing surgery when inappropriate. See online Supplementary Table 1.

Outcomes

We used two widely used and well-validated instruments.^{18–22} The Boston Carpal Tunnel Questionnaire includes a Symptom Severity subscale (BCTQ-SS) and a Functional Status subscale (BCTQ-FS). Scores refer to a typical 24-hour period in the prior two weeks, represent the mean of included items, and range from 1 to 5 (lower is better).^{23,24} The Short Form Health Survey, version 2 (SF-12v2) includes Physical and Mental Component Scores (PCS and MCS, respectively). Norm-based scores range from 0 to 100 (higher is better), for which a general population has a mean of 50 (standard deviation [SD] 10).^{25–27}

The four study outcomes included *changes over 18 months* in symptom severity (BCTQ-SS weighted), functional status (BCTQ-FS), physical health (SF-12v2 PCS), and mental health (SF-12v2 MCS). We used Cronbach's alpha to evaluate the internal consistency of BCTQ subscales within our analytical cohort.²⁸ We were unable to assess this for the SF-12v2 because scoring is proprietary.

Other Variables

Covariates derived from survey data included handedness, hand(s) subject to workers' compensation claim, age, gender, race/Hispanic ethnicity, log of personal income at baseline, medical risk factors for CTS (thyroid disease, kidney disease, arthritis, or obesity; yes, no), occupation (5 categories from U.S. Census Bureau),²⁹ job satisfaction before CTS (1–4, 1=best), safety climate at work (1–4, 1=best),³⁰ duration of symptoms, locations of symptoms in hand and wrist, timing of symptoms (constant, intermittent), baseline self-efficacy in managing CTS symptoms (1–4, 1=best),³¹ prior workers' compensation claims for hand/wrist conditions (yes, no) and hand(s) involved. The survey at 18 months asked whether an expert had evaluated the patient's job tasks and recommended changes, the employer had made changes to minimize exposures that exacerbate the patient's symptoms, the patient was using force or vibrating power tools, an attorney was involved in the claim, and the patient had received care for CTS prior or concurrent to the care provided by KPNC Occupational Health Centers.

Variables based on medical record data included timing of presentation (days between diagnosis and first visit to occupational health for symptoms related to CTS), neurological signs (any thenar atrophy, thenar weakness, or loss of sensibility in digits 1–3 documented by the treating physician; yes, no), electrodiagnostic test results (any positive test, not), symptom timing (constant, intermittent, unclear/missing), and clinical probability of CTS (classic/probable per Katz Diagram vs. not, based on location of symptoms).³²

Main Analysis

We used multivariate linear regression models to predict changes in the four study outcome measures based on quality of care and covariates. To present results in a format that was easy to understand, we compared outcomes between hypothetical patients who received better care than 80% of study subjects and hypothetical patients who received worse care

than 80% of study subjects. Specifically, we used results from the regression models and set the values of covariates to population means to estimated mean predicted BCTQ and SF-12v2 scores for patients at the 20th and 80th percentiles of adherence, and then calculated differences in predicted outcomes between these percentiles along with 95% confidence intervals (95% CIs) for these differences. For the eight main analyses, we also calculated effect sizes (ES, Cohen's d calculated as the difference between two groups on an outcome measure divided by the standard deviation for that measure). See online Supplementary Material.

In *a priori* power calculations, with 550 patients, we would have had 79% power to detect a 0.17-point difference in weighted BCTQ-SS scores at 18 months for two groups stratified on a dichotomous variable, assuming a SD of 0.72 and a standard error of the difference between the groups of 0.0614.

Because there were eight main analyses, we calculated p-values before and after adjusting for multiple comparisons using the Benjamini Hochberg procedure for controlling the false discover rate³³ (FDR).

Secondary Analyses

We performed four sets of secondary analyses. First, in pre-specified analyses, we examined associations between outcomes and underuse of evaluation and monitoring (10 measures), non-operative treatment (4 measures), and activity assessment and management (10 measures); as well as surgical appropriateness (receipt of necessary surgery, avoidance of inappropriate surgery, and receipt of surgery when of uncertain appropriateness).

Second, we examined the roles of job factors and attorney involvement, including whether an expert evaluated job tasks and recommended changes (yes, no), whether the employer made changes to minimize exposures that exacerbated the patient's CTS symptoms (yes to any of 4 items, no), whether the patient's job currently required the use of force such as lifting or pushing or use vibrating power tools (yes to either of 2 items, no), and whether an attorney was involved in the workers' compensation claim (yes, no).

Third, because preliminary results suggested that overuse was (counterintuitively) associated with improved outcomes and that this may be related to medications that are not recommended for CTS, we examined measures related to prescribing of non-steroidal anti-inflammatory drugs (NSAIDs), muscle relaxants, and opioids, and an aggregate adherence score that encompassed all other overuse.

Finally, we restricted the sample to patients with classic/probable symptoms and positive electrodiagnostic tests, as per a published consensus definition of CTS.³⁴

Results

Of 1009 individuals with newly coded diagnoses of CTS, 630 consented (67.9% after excluding 81 who were ineligible), 509 completed the baseline survey (83.0% after excluding 17 who were ineligible), 429 completed the follow-up survey (84.3% of respondents to baseline survey), 477 underwent medical record review (32 were ineligible),

and 343 had complete data (see Figure 1). The diagnosis of CTS was reversed in 20 patients, and the workers' compensation claim was dropped or denied in 19. The mean age was 48 years, 76.1% of subjects were female, 49.9% were white. Most subjects had medical risk factors for CTS (especially being overweight), constant symptoms, and low job satisfaction. Online Supplementary Material describes the study population.¹²

Quality of Care:

Overall, quality was good and variation across patients was limited. Patients received 78.5% of necessary care (SD 16.3%; 20th percentile 68.7%, 80th percentile 90.3%), including 83.9% of necessary evaluation and management (SD 20.9%), 47.6% of necessary non-operative treatment (SD 27.0%), and 81.2% of necessary activity assessment and management (SD 20.5%). Patients avoided 89.2% of inappropriate care (SD 11.0%; 20th percentile 82.2%, 80th percentile 100%).

Patient-reported Outcomes:

BCTQ subscales had good internal consistency in our cohort (Cronbach's alphas: BCTQ-SS 0.867, and BCTQ-FS 0.846).³⁵ Over 18 months, significant improvements occurred in symptom severity (mean BCTQ-SS -0.83 , SD 0.97, p -value for test of nonzero mean <0.001), functional status (mean BCTQ-FS -0.65 , SD 0.98, $p<0.001$), and physical health (mean SF-12v2 PCS 3.82, SD 10.0, $p<0.001$). Mental health was unchanged (mean SF-12v2 MCS 0.95, SD 10.8, $p=0.107$).

Main Results

Underuse: As shown in Figure 2, patients who received better care (80th percentile of adherence) experienced 24% larger improvements in symptoms (BCTQ-SS -0.18 , 95% CI -0.32 to -0.05 , ES 0.19), 38% larger improvements in functional status (BCTQ-FS -0.21 , 95% CI -0.34 to -0.08 , ES 0.21), 58% larger improvements in physical health (SF12-v2 PCS 1.75, 95% CI 0.33 to 3.16, ES 0.18), and no significant changes in mental health (SF12-v2 MCS 1.24, 95% CI -0.18 to 2.66, ES 0.12) compared with patients who received worse care (20th percentile). P -values for the BCTQ-SS, BCTQ-FS, and SF-12v2 PCS were significant at <0.05 before and after adjusting for multiple comparisons; the p -value for the SF-12v2 MCS exceeded 0.05 before and after adjustment. See online Supplementary Material.

Overuse: Counterintuitively, avoiding overuse was associated with *smaller* improvements in symptoms. Compared with patients who received worse care, patients who received better care tended to experience 17% smaller improvements (BCTQ-SS 0.15, 95% CI 0.01 to 0.30, ES 0.15). After adjusting for multiple comparisons, this association was no longer significant (raw $p=0.04$, adjusted $p=0.09$); see online Supplementary Material. Overuse was not associated with functional status, physical health, or mental health.

Secondary Analyses

Evaluation and Monitoring: Patients who received better care experienced 23% larger improvements in functional status (BCTQ-FS -0.14 , 95% CI -0.26 to -0.03 ; Figure 3), but symptom severity, physical health, and mental health were unchanged.

Non-operative Treatment: Quality of care was not associated with symptoms, functional status, physical health, or mental health.

Activity Assessment and Management: Patients who received better care experienced 24% larger improvements in symptoms (BCTQ-SS -0.19 , 95% CI -0.31 to -0.07), 36% larger improvements in functional status (BCTQ-FS -0.21 , 95% CI -0.33 to -0.09), and 56% larger improvements in physical health (SF12-v2 PCS 1.87 , 95% CI 0.58 to 3.17); mental health did not change.

Surgery: Among 100 patients for whom surgery was necessary, undergoing surgery was associated with 158% larger improvements in symptoms (BCTQ-SS -0.60 , 95% CI -1.11 to -0.09). Among 159 people for whom surgery was of uncertain appropriateness, undergoing surgery was associated with 132% larger improvement in symptoms (BCTQ-SS -0.52 , 95% CI -0.79 to -0.25) and 45% larger improvement in functional status (BCTQ-FS -0.36 , 95% CI -0.62 to -0.09). Only 4 of 75 patients underwent inappropriate surgery so meaningful conclusions cannot be drawn. See Figure 4.

Medications: We performed a secondary analysis to test whether overuse of medications might explain the unexpected association between overuse and improvement in symptoms; findings were somewhat contradictory. On the one hand, symptoms did not differ among patients who were prescribed NSAIDs (BCTQ-SS -0.15 , 95% CI -0.04 to 0.35), muscle relaxants (BCTQ-SS -0.19 , 95% CI -0.28 to 0.65), and opioids (BCTQ-SS -0.14 , 95% CI -0.33 to 0.60) that were not recommended. On the other hand, after adjusting for use of these medications, remaining overuse measures were not associated with outcomes.

Job Factors at Follow-up: Forty-four percent of subjects reported that an expert evaluated their job tasks and recommended changes; symptoms and functional status were not significantly different among these individuals (BCTQ-SS -0.17 , 95% CI -0.02 to 0.35 ; BCTQ-FS -0.17 , 95% CI -0.01 to 0.36). Forty percent of subjects reported that employers made changes to minimize exposures that exacerbated their symptoms, but this was not associated with significant changes in symptoms or functional status (BCTQ-SS -0.18 , 95% CI -0.36 to 0.00 ; BCTQ-FS 0.02 , 95% CI -1.17 to 0.20). Forty-nine percent of subjects reported that their jobs required the use of force (such as lifting or pushing) or vibrating power tools; NOT reporting these exposures was associated with 35% *larger* improvements in symptoms (BCTQ-SS -0.25 , 95% CI 0.06 to 0.43) but not changes in functional status (BCTQ-FS -0.11 , 95% CI -0.30 to 0.08). Patients who did NOT retain an attorney experienced significantly *larger* improvements in symptoms (BCTQ-SS -0.43 , 95% CI -0.68 to -0.18) but not functional status (BCTQ-FS -0.17 , 95% CI -0.43 to 0.08).

Classic/Probable Symptoms and Positive Electrodiagnostic Tests: Among the 134 patients with these characteristics, patients who received better care on underuse measures had even larger improvements in symptoms (BCTQ-SS -0.25 , 95% CI -0.46 to -0.05) and functional status (BCTQ-FS -0.24 , 95% CI -0.44 to -0.04). However, differences in physical health (SF-12v2 PCS 0.93 , 95% CI -1.14 to 3.00) and mental health (SF-12v2 MCS 0.45 , 95% CI -1.2697 to 2.17) were not significant.

Discussion

In this prospective observational study of 343 individuals with CTS, receiving better care during the year after study enrollment was associated with significantly larger improvements in patient-reported outcomes at 18 months, including symptoms, functional status, and overall physical health. Two aspects of care were important. First, receiving surgery when necessary was associated with reductions in symptom severity. Second, symptoms, functional status, and physical health all improved when physicians adhered to recommended care processes related to assessing and managing activity, meaning that they elicited triggers for symptoms at work and at home, recommended changes to activities that trigger symptoms, and monitored the ability to work. Improvements in symptoms also occurred when employers helped patients to avoid exacerbating activities.

In prior studies, outcomes among patients with CTS have varied with age, gender, symptom severity, bilateral symptoms, thenar atrophy, smoking and alcohol use, income, job classification, exposure to force and repetition, the supportiveness of the work environment, compensation via a claim, and attorney involvement, among other factors.^{36–39,30,40} Our work demonstrates that outcomes also vary with quality of care.

In addition to being statistically significant, were the improvements in symptoms that we observed clinically meaningful? Effect sizes in the main analyses of underuse and overuse were generally small (0.15 to 0.21 for statistically significant findings), and changes in BCTQ-SS scores were similar to or smaller than the smallest changes in treatment outcomes that patients have considered important (minimal important differences) in prior studies. According to a systematic review of changes in outcomes following hand surgery, minimal important differences ranged from 0.16 to 1.85 for the BCTQ-SS.⁴¹ In comparison, when patients with classic/probable CTS and positive electrodiagnostic tests received better care, they experienced 0.25 -point larger improvements in BCTQ-SS scores.

In general, detecting associations between the quality of care processes and outcomes can be challenging, which may explain why few of the process-related quality measures in use today have been validated.¹ Several specific factors may have reduced the magnitude of the improvements in outcomes that we detected. Adherence to the CTS quality measures was relatively high and variation in adherence was modest. Documentation in medical records is often incomplete, scoring the measures involved subjective judgments, and reliability was imperfect, creating statistical noise that could mask effects. Some patients received care before presenting to occupational health, making them ineligible for certain measures. Other patients were later found to not have CTS, so the BCTQ was not as responsive.

Few studies have examined associations between quality of care and outcomes for musculoskeletal disorders, despite their frequency among working age adults, symptom burden, and effects on function. Medicare and commercial health insurers are shifting to reimbursement models that reward quality and value, hoping to improve clinical outcomes as well as avert costs that arise when worse outcomes lead to greater healthcare utilization.^{42–44} In many states, workers' compensation policymakers have implemented utilization review guidelines to limit overuse. Less attention is paid to ensuring that patients with musculoskeletal disorders receive necessary care that promotes recovery.⁶ Future research should evaluate whether systematic efforts to assure that patients with CTS receive higher quality care may be beneficial.

Our results suggest two priorities for future tests of improvement efforts. The first priority is offering surgery when criteria for necessity are met, based on symptom duration and severity, the clinical probability of CTS, neurological signs, electrodiagnostic testing, and the response to nonoperative management. We found that undergoing necessary surgery was associated with relatively larger improvements in symptoms. Outcomes improved even when surgery was of uncertain appropriateness; the reason for this association is unclear, and a placebo effect cannot be excluded. According to our criteria, surgery should mainly be avoided when conservative therapy has not been attempted and symptoms are atypical, mild to moderate, and/or not confirmed by electrodiagnostic testing.

The second priority for improvement efforts is assessing and managing patient activity, including coordinating these efforts with employers, because these were associated with relatively larger improvements in outcomes. After workers' compensation policymakers in Washington State gave physicians financial incentives to communicate with employers, prescribe appropriate activity, and assess barriers to return to work, disability days declined by 20%.⁴⁵ Time off work imposes a substantial economic burden on workers, employers, and healthcare payers.⁷ Yet, in our study, employers made changes to job tasks only 40% of the time.

There are several limitations. With an observational design, we do not know that better care caused better outcomes. Variables, such as neurological signs, were based on information documented by physicians. The unexpected association between NSAIDs and symptoms might be explained by a placebo effect, confounding by indication, benefits not detected in prior randomized trials, improvements in other causes of pain, or chance.^{46–48} Although several years have passed since we developed our measures, they are consistent with recent systematic reviews.^{49,50} The severity of CTS symptoms and quality of care may differ between patients treated by occupational medicine physicians and primary care providers. Quality of care may also differ in other settings because KPNC Regional Occupational Health has systems for clinical quality assurance that are not widely used for musculoskeletal disorders.^{5,51}

In conclusion, better care—specifically, receiving necessary care—for CTS is associated with significant improvements in symptoms. Efforts should be made to ensure that patients with CTS receive essential care processes including necessary surgery and activity assessment and management by physicians.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Abbreviations

CTS	carpal tunnel syndrome
KPNC	Kaiser Permanente Northern California
BCTQ	Boston Carpal Tunnel Questionnaire
BCTQ-SS	symptom severity subscale
BCTQ-FS	functional status subscale
SF-12v2	Short Form Health Survey, version 2
SF-12v2 PCS	Physical Component Scores
SF-12v2 MCS	Mental Component Scores
	change in
SD	standard deviation
ICD-9	International Classification of Diseases version 9

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Figure 1:
Enrollment of Study Subjects, Survey Responses, and Medical Record Review

Figure 2: Difference in Predicted Change in Outcomes for Hypothetical Patients Receiving Better vs. Worse Care, Based on Adherence to Measures of Underuse and Overuse

A. Boston Carpal Tunnel Questionnaire, Change in Symptom Severity Score (BCTQ-SS, N = 393)*

B. Boston Carpal Tunnel Questionnaire, Change in Functional Status Score (BCTQ-FS, N = 393)*

C. SF-12v2, Change in Physical Component Score (SF-12v2 PCS, N = 338)†

D. SF-12v2, Change in Mental Component Score (SF-12v2 MCS, N = 338)†

Legend: Worse Care (20th percentile) Better Care (80th Percentile)

* Scaled 1–5, 1=best

† Scaled 0–100, 100=best, norm-based scores with mean of 50 and standard deviation of 10

Figure 3: Difference in Predicted Change in Outcomes for Hypothetical Patients Receiving Better vs. Worse Care, Based on Adherence to Measures of Underuse for Three Aspects of Care
 A. Boston Carpal Tunnel Questionnaire, Change in Symptom Severity Score (BCTQ-SS, N = 241)*

B. Boston Carpal Tunnel Questionnaire, Change in Functional Status Score (BCTQ-FS, N = 241)*

C. SF-12v2, Change in Physical Component Score (SF-12v2 PCS, N = 239)†

D. SF-12v2, Change in Mental Component Score (SF-12v2 MCS, N = 239)†

Legend: □ Worse Care (20th percentile) ■ Better Care (80th Percentile)

* Scaled 1–5, 1=best

† Scaled 0–100, 100=best, norm-based scores with mean of 50 and standard deviation of 10

Figure 4: Difference in Predicted Change in Outcomes for Patients that Did vs. Did Not Receive Surgery, by the Appropriateness of Surgery

A. Boston Carpal Tunnel Questionnaire, Change in Symptom Severity Score (BCTQ-SS)*

B. Boston Carpal Tunnel Questionnaire, Change in Functional Status Score (BCTQ-FS)*

C. SF-12v2, Change in Physical Component Score (SF-12v2 PCS)†

D. SF-12v2, Change in Mental Component Score (SF-12v2 MCS)†

Legend: Surgery Not Received Surgery Received

* Scaled 1–5, 1=best

† Scaled 0–100, 100=best, norm-based scores with mean of 50 and standard deviation of 10