Conservative Care Options for Occupational Carpal Tunnel Syndrome

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Purpose and Intended Use

This document updates a 2009 resource developed by the Industrial Insurance Chiropractic Advisory Committee (IICAC) of the Washington State Department of Labor and Industries. It provides concise summaries of published clinical and scientific literature regarding utility and effectiveness of commonly used conservative approaches for work-related carpal tunnel syndrome (CTS); history, examination and special studies, recommendations for supportive, manual, and rehabilitative care including practical clinical resources (useable without licensing/charge in practice for non-commercial use). It is intended to inform care options and shared decision-making. It is not a standard of care, claim management standard, or a substitute for clinical judgment in an individual case. This practice resource does not change L&I coverage or payment policies.

A comprehensive search of available scientific literature on conservative assessment and intervention procedures for carpal tunnel syndrome was conducted by the Policy, Practice, and Quality (PPQ) Subcommittee of the IICAC and department staff during Spring 2013. Literature was reviewed, assessed for relevance and quality and summaries were drafted by consensus of the subcommittee with expert content input from consultants and reviewers, including the Industrial Insurance Medical Advisory Committee and selected relevant professional societies in September 2013. The updated resource was posted for public comment and revision, and approved for distribution by the IICAC in October 2013. A minor update was made and approved at its April 2014 meeting. This resource is expected to be updated periodically by the IICAC. Interested parties may submit new published scientific report for consideration for future revisions.

This and other practice resources are available for download at the State of Washington Department of Labor & Industries website. Contact information for public input and submission of studies for future revisions is available there.

http://www.lni.wa.gov/ClaimsIns/Providers/ProjResearchComm/IICAC/default.asp#5

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PRACTICAL APPLICATION POINTS

- Work-relatedness usually involves high force, extreme posture work (e.g. meat cutting, roofing); rarely is low force, repetitive work a cause.
- Typical presentation of median nerve entrapment is burning pain on thenar side, especially after work and at night. Hand diagram is more useful than provocative tests.
- Electrodiagnostic studies (EDS) are necessary for diagnostic certainty, CTS surgery requests, or when time loss (TL) exceeds 2 weeks.
- Conservative treatment may be warranted if substantial symptomatic and functional progress is evident. Surgical release of median nerve entrapment is typically more effective than conservative measures.

Work-Related Carpal Tunnel Syndrome

Work-related CTS is associated with significant preventable disability. Accurate, timely diagnosis and establishment of work-relatedness is critical to prevent delays and ensure optimal outcomes. Electrodiagnostic studies (EDS), showing delayed median nerve conduction velocity (NCV) across the carpal tunnel provides definitive diagnosis. Some clinical tests correlate with EDS. Between 30-70% of CTS patients may fully recover with certain conservative interventions within a few weeks to a few months. However, 90% of CTS patients fully recover within a few weeks after surgical release of the carpal tunnel. Response to either intervention may be better when care begins early. Due to high success and low risk associated with carpal tunnel surgery, a failure to obtain timely improvement in symptoms and function from a conservative trial warrants timely consideration of specialist referral.

Case Definition

- Clinical presentation of median nerve entrapment (thenar pain/paresthesia, often after work and at night)
- Work place exposure to known CTS inducing activities
- Corroboration of diagnosis by EDS (the latter is most important when response to conservative care is delayed, time loss (TL) exceeds 2 weeks, and/or CTS release surgery is being considered/authorized)

Evaluation Summary

- Rule-in median nerve entrapment initially with validated clinical methods (symptoms, work exposure, motor function, provocative testing)
- Monitor symptoms, motor function, provocability, & work status to document improvement
- Make an early referral for EDS and/or specialist consult if: a) symptomatic for over 6-12 months prior to claim acceptance, as conservative care is less likely to benefit; b) time-loss exceeds 2 weeks; or c) significant improvement, including ability to work is not attained within the first several weeks of conservative care.

Intervention Summary

- Nocturnal wrist splinting with daytime use as needed to control symptoms when using hands
- Improvement may be hastened with additional mobility interventions (e.g., wrist stretching exercises, wrist manipulation/mobilization)
- For diagnostic and surgical referral (particularly in underserved areas) consider assistance from a care coordinator, e.g., from COHE

The Department of Labor & Industries' Work-Related Carpal Tunnel Syndrome Diagnosis & Treatment Guideline has additional information, particularly related to EDS and surgery: http://www.lni.wa.gov/ClaimsIns/Providers/ProjResearchComm/PAC

Typical Interventions and Approximate Response Thresholds

1-2 wks	3-6 wks	7-8 wks	Beyond 8 wks
• Nocturnal wrist splint with daytime use as needed, • Consider wrist mobilization, myofascial work, stretching/exercise • Consider work activity, flow, site modification • Consider corroboration of clinical impression with EDS	• Improvement (e.g., hand diagram, pinch strength): decrease splint use, reduce care frequency, increase self-mobility, stretching, continue work modifications, • Inadequate improvement: continue splint use 2 weeks, alter additional interventions, & consider additional work modification; EDS required if time loss (TL) > 2 weeks	• Good Improvement: progressively decrease splint use, reduce care frequency, consider normal work activity • Inadequate improvement: review compliance with self-care; consider specialty referral & EDS (required if TL > 2 weeks)	• Good Improvement: increase reliance on self-directed care, splint use as needed, • Inadequate improvement: specialty referral & EDS (required if TL > 2 weeks) if not already scheduled

CTS PROGRESS CHECKLIST

Voluntary educational / practice aid – Not an L&I documentation requirement

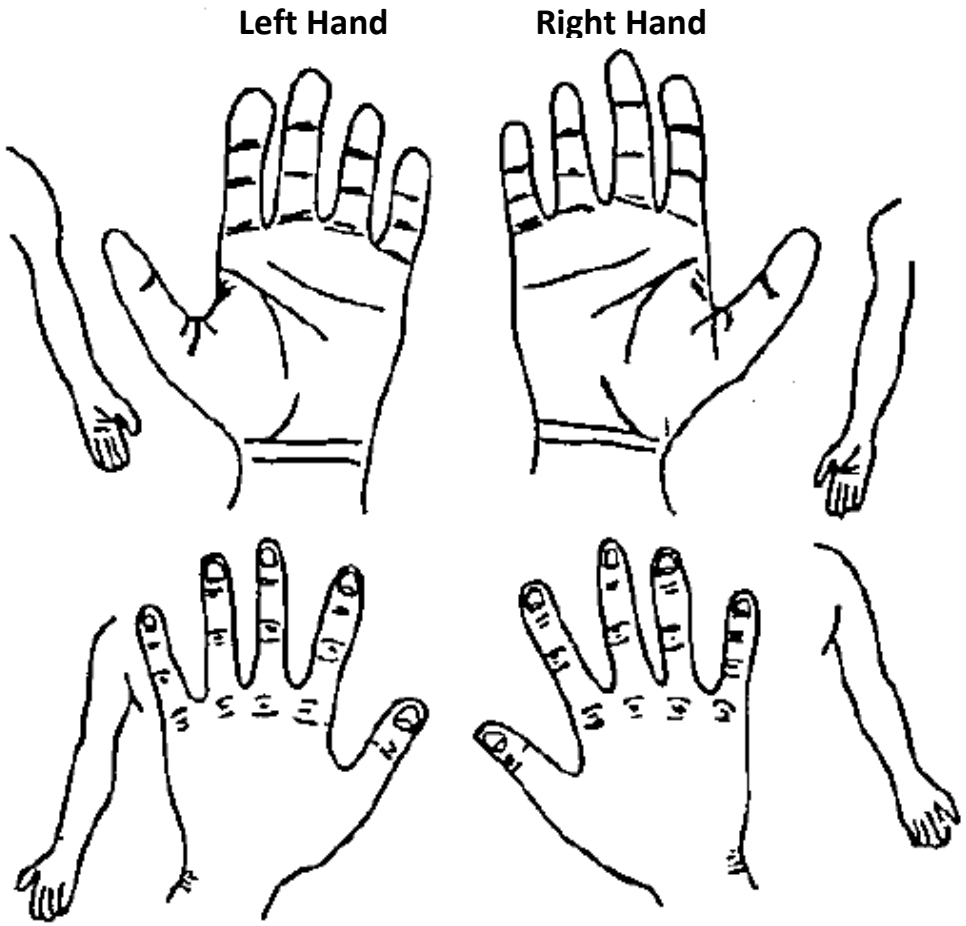
Baseline → 1-2 wks → 3-6 wks → 7-8 wks → Beyond 8 wks

Assessment / Progress

Date: Document tasks & wrist/hand positions at symptom onset: Work time before symptom onset: __________________ hours Nocturnal symptoms: ☐ none ☐ 1-2 nights/week ☐ 3-4 nights/week ☐ > 5 nights/week ☐ mild ☐ moderate ☐ severe ☐ Baseline hand diagram - Document areas of hypalgesia Motor strength Tip pinch grip: _________ Thumb abduction: __________	Date: Document tasks & wrist/hand positions at symptom onset: Work time before symptom onset: __________________ hours Nocturnal symptoms: ☐ none ☐ 1-2 nights/week ☐ 3-4 nights/week ☐ > 5 nights/week ☐ mild ☐ moderate ☐ severe ☐ Baseline hand diagram - Document areas of hypalgesia Motor strength Tip pinch grip: _________ Thumb abduction: __________	Date: Document tasks & wrist/hand positions at symptom onset: Work time before symptom onset: __________________ hours Nocturnal symptoms: ☐ none ☐ 1-2 nights/week ☐ 3-4 nights/week ☐ > 5 nights/week ☐ mild ☐ moderate ☐ severe ☐ Baseline hand diagram - Document areas of hypalgesia Motor strength Tip pinch grip: _________ Thumb abduction: __________	Date: Document tasks & wrist/hand positions at symptom onset: Work time before symptom onset: __________________ hours Nocturnal symptoms: ☐ none ☐ 1-2 nights/week ☐ 3-4 nights/week ☐ > 5 nights/week ☐ mild ☐ moderate ☐ severe ☐ Baseline hand diagram - Document areas of hypalgesia Motor strength Tip pinch grip: _________ Thumb abduction: __________

Intervention Options

Manual • Nocturnal splinting • Daytime splint use PRN • Wrist mobilization/myofascial • Systematic stretching, home stretching exercise (e.g. wrist stretches, nerve gliding), • Consider work activity, flow, site modification **Modalities/Meds** • Pulsed ultrasound, low level laser therapy, oral & injected steroids shown to provide temporary relief	**Manual** Increase self-mobility, reduce splint use and passive interventions • Nocturnal splinting • Daytime splint use PRN • Wrist mobilization/myofascial • Systematic stretching, home stretching exercise (e.g. wrist stretches, tendon/nerve gliding), • Consider work activity, flow, site modification	**Good Improvement** (decreased nocturnal pain, reduced distribution and severity, increased pinch grip, returned to work) • Progressively decrease splint use • Increase self-care & reduce care frequency • Progressively resume normal work activity **Inadequate improvement** (continued nocturnal pain, little to no reduction in distribution and severity, continued weakness, continued time loss) • Consider referral for electrodiagnostic studies, and or specialty/surgical referral if not already scheduled Patient Name: ______________________________________



Patient Name_____

Claim # _____ Date: _____

LEGEND

Pain	_____ _____ _____
Tingling	| | | | | | | | | | | | | | | |
Numbness	\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \
Decreased Sensation	X X X X X X X X X X X X X X X X X X

FOR OFFICE USE
COMMENTS:

INTERPRETATION:

Validity of these patterns to correlate with NCV is good:

- Classic: ≥2 out of digits 1,2,3; no palm
- Probable: ≥2 out of digits 1,2,3; palm OK if not ulnar only

* Permission to use this hand diagram was obtained from Dr. Jeffrey N. Katz. The legend was modified for better readability.

CTS CLINICAL ASSESSMENT SUMMARY

Occupational CTS Case Definition

Policy Standard for L&I Claim Acceptance

Clinical presentation of median nerve entrapment

- Burning pain, paresthesia; one or both hands along median (thenar side) nerve distribution; often more evident after shift or at night. [1]
- Provocative tests (e.g. sustained pressure, tapping over carpal tunnel area) may aggravate symptoms.
- Other causes of wrist/hand symptoms ruled out (e.g., tendonitis, sprain/strain, myofascial and joint dysfunctions, cervicogenic referral) [1]

Work place exposure to CTS inducing activity [2-4]

- High probability of work-relatedness:
  - Combination of high force & repetition; extreme posture in flexion, extension, and/or deviation (e.g., meat cutting, carpentry, roofing, book binding)
- Medium probability of work-relatedness:
  - Medium force & continuous repetition/awkward posture (e.g. Dental hygienist); sustained vibration (e.g., jackhammer)
- Low probability of work-relatedness:
  - Intermittent low force & repetition (keyboard >20 hr/wk, cashier)

Corroboration of CTS diagnosis by nerve conduction velocity (NCV) testing [5, 6]

- Required by L&I when time loss > 2 weeks
- Needed for confirmation of diagnosis for CTS surgery request
- NCV most useful in long-standing symptoms.
- Refer to L&I CTS guideline for criteria summary

HISTORY – Diagnostic/Severity Indicators

Patient Presentation

- Classic CTS presentation includes burning pain, paresthesia; one or both hands along median (thenar side) nerve distribution; often more evident after shift or at night
- A study of 91 patients compared clinical criteria on presentation (signs and symptoms based on Levine Scale and CTS-6 scale), along with psychosocial factors (depression, heightened illness concern and pain catastrophizing) with NCV testing. Signs and symptom of CTS correlated with NCV tests; however factors did not distinguish between normal and abnormal NCV findings. [7]

Nocturnal Symptoms

- In a systematic review addressing studies of physical examination for diagnosing carpal tunnel syndrome, the absence of nocturnal symptoms was reported to correlate with negative NCV tests. The presence of nocturnal symptoms occurs in about 2/3 of CTS cases.[8]
- Nocturnal Symptoms: Patient awakes with hand, wrist, and forearm complaints of discomfort, numbness, tingling, and fullness which improve with movement /shaking of extremity.[1]

Function Questionnaires

- **Carpal Tunnel Syndrome Assessment Questionnaire (CTSAQ)** also known as the **Boston Carpal Tunnel Questionnaire (BCTQ) –** A self-administered symptom severity questionnaire that has been used in population-based research trials for which psychometric properties have been validated. It includes symptom severity and function subscales. It has demonstrated sensitivity to pre- and post-surgery changes in self-reported severity of wrist symptoms and several basic activities of daily living. It does not appear to have been correlated to NCV findings and does assess typical work tasks or durations [9, 10]. An on-line source for the scale could not be found, but numerous sources for the instrument and information can be found online searching by the

instrument names.

- **Michigan Hand Outcome Questionnaire (MHQ) -** Developed to measure the health state domains important to patients with hand disorders. The instrument is used to evaluate a patient prior to hand surgery and after the surgery. It is a lengthy questionnaire mostly used in a research setting. It has been shown have to good validity, reliability, and responsiveness in documenting change in CTS patients.[11] The pain and function domains of MHQ appear to discriminate well between patients who report being satisfied with their surgical outcomes (minimally important change has been reported to be 23, 13, and 8 for pain, function and work domains respectively [12]. A shorter 12-item version has been validated against the original with high responsiveness for all diseases including CTS and across time periods [13]. A brief MHQ version with scoring instructions can be found at http://sitemaker.umich.edu/mhq/brief_mhq.
- **Quick Disabilities of the Arm Shoulder and Hand (QuickDASH)** - is a self-report questionnaire designed to measure physical functions and symptoms in people with any of the several musculoskeletal disorders of the upper limb. It is a validated measure with widespread use. Reliability and reproducibility for hand and wrist function have been demonstrated in several studies. Responsiveness of the full DASH questionnaire has been demonstrated to be comparable to the CTSAQ preoperatively and 3 months postoperatively [14]. DASH has also been demonstrated to be comparable in responsiveness to change in CTS patients preoperatively, 3 months and 6 month post-operatively with the MHQ and the Patient Specific Functional Questionnaire [15]. The Quick DASH is available for use at http://dash.iwh.on.ca/conditions-use

Hand Diagram

- **Katz Hand Diagram** - Patient-administered diagram of dorsal & palmar hand marking and characterizing the locations of pain, numbness, tingling or decreased sensation. Validated for diagnostic properties as follows: [8, 16] for
  - Classic: ≥2 out of digits 1,2,3; no palm
  - Probable: ≥2 out of digits 1,2,3; palm OK if not ulnar only
  - Possible: ≥1 out of digits 1,2,3; palm OK if not ulnar only
  - Unlikely: 0 out of digits 1,2,3

Potentially useful for assessing symptom distribution following intervention, but not specifically validated for that purpose.

HISTORY – Prognostic Indicators

Risk Factors for Prolonged Disability

- The following factors may predict greater risk of longer temporary disability and assist in care planning, specialty consultation, determining need for return-to-work assistance from L&I.
  - Strenuous hand/wrist activity on RTW
  - Twisting end range exposure preoperatively
  - Low mental health status
  - High preoperative absence from work
  - Female gender
  - Obesity
  - Elderly with more severe symptoms, more likely to have surgery
  - Persistent postoperative symptoms
  - Long term absence associated with psychosocial factors (low pay, high job stress, low co-worker support, job-insecurity, low employer support)

Note: Pre-operative NCV severity does not appear to be associated with longer disability duration

CLINICAL EXAMINATION – Physical Exam

Functional Deficit Tests

- **Median Nerve Distribution Hypalgesia -** Decreased sensitivity to pain along palmar aspect of index finger when compared to little finger on same hand. This appears to be highly predictive of NCV findings with good sensitivity and specificity. [8]
- **Weak Thumb Abduction Strength -** Patient raises thumb perpendicular to the palm as downward pressure/resistance is applied

to the distal phalanx. Average specificity and sensitivity for finding of weakness. However, a finding of normal thumb abduction strength did not correlate with a negative NCV test. [8]

- **Grip Strength** Tip pinch dynamometry appear to be one of the most responsive, reliable, and valid quantitative non-NCV approaches to target measurement of thenar muscle strength for recovery from CTS surgery. More study is needed however.[17]
- **Thenar Atrophy -** Visual assessment of thenar size. May be NCV predictive in late CTS, but pre-atrophy symptoms usually prompts care seeking, so sensitivity is low. Further, thenar atrophy results from other conditions (cervical radiculopathy, brachial plexus lesions). [8]
- **Square Wrist Sign -** This sign is positive when the ratio of a patient's wrist thickness to wrist width (as measured by calipers) is greater than 0.7 (i.e., wrist is more square shaped than rectangular shaped). In one study 69% of people with NCV confirmed CTS were positive. Limited study to date. [8, 18, 19]

Provocation & Relief Maneuvers

- **Closed Fist Sign -** This sign is positive when an increased sensation of numbness, tingling and perhaps pain is reported by a patient after tightly clenching the affected fist for 60 seconds. Limited study to date. Potentially NCV predictive [8]
- **Pressure Provocation -** Direct (sustained as opposed to tapping) pressure with thumb/cuff over carpal tunnel elicits/exacerbates symptoms. Test is not NCV predictive [*8, 20*]
- **Phalen's Sign -** Sustained maximal wrist flexion to compress carpal tunnel elicits/exacerbates symptoms. Although commonly employed, the test is not NCV predictive. [8]
- **Tinel's Sign-** Tapping with digit over carpal tunnel to elicit/exacerbate symptoms is a standard widespread test, however its sensitivity and specificity are low and it is not predictive of NCV findings. [8]
- **Flick Sign -** Assessed by historical inquiry. For patients with acroparesthesia (heaviness & numbness as opposed to pain as the primary complaint), relief is obtained by shacking or flicking the affected hand(s). For patients primarily complaining of hand pain, the test may not be predictive. Contradictory and limited studies exist to date. [8, 21, 22]
- **Hand Elevation Test –** Patient raises their hand overhead for a couple of minutes to produce symptoms of CTS. if symptoms are reproduced the test is considered positive. It is reported to be more specific and sensitive than Tinel's and Phalen's test. [23, 24]
- **Combining Multiple Provocative Tests** - A few studies have suggested increased utility when multiple clinical tests and signs are combined (e.g., combined Tinel and Katz findings of classic/probable), but little to no advantage over individual signs has been demonstrated [8]

SPECIALIZED EXAMINATION – Electro Diagnostic Studies (EDS)

Nerve Conduction Velocity (NCV)

- NCV testing remains the benchmark of median nerve involvement with findings of longer conduction times (slowing) of motor and sensory fibers between the arm and palm compared to other nerves. Without these findings, carpal tunnel surgical release outcomes are poor. Less than 10% of CTS patients have normal NCV findings. Thus NCV is useful for definitive diagnosis of CTS and predicts positive outcome from surgical release when there is an inadequate response to appropriate conservative intervention. (See Conservative Interventions Matrix) (L&I CTS Guideline 2009) [25, 26]
- In a Turkish diagnostic accuracy study of 69 patients with clinical symptoms of CTS, EMG was compared to imaging studies including ultrasound, CT, and MRI. EMG was reported to have the highest sensitivity (90.9% and a specificity of 81.2% ($p<0.001$). All other imaging modalities were reported to have lower but acceptable accuracy. All parameters of the four tests had sufficient diagnostic performance. [27]
- Near or near normal pre-operative NCV findings were associated with poorer post-surgical outcomes in workers with CTS compared to workers whose pre-operative NCV findings indicated median nerve entrapment. [28]

Combined Sensory Index (CSI) for Nerve Conduction Velocity

- CSI combines results of 3 NCV tests at different locations on the hand instead of one location. This approach reduces sensitivity compared to a single test, but increases specificity to 100% when all three tests are included. The use of multiple tests is proposed to improve diagnostic accuracy. [29-31]

IMAGING STUDIES

MRI and CT

MRI and CT are not currently covered under L&I to rule-in or for confirmation of CTS. However, if the diagnosis remains ambiguous following NCV testing and there is a poor response to conservative intervention, advanced imaging may be indicated.

- Both MRI and CT measurements of distal median nerve cross-sectional area were reported as having acceptable diagnostic accuracy compared to clinical criteria (see NCV section above). Because of lower sensitivity and specificity than EMG and the higher cost of MRI or CT, advanced imaging was not recommended for first-line diagnostic confirmation.[27]
- Smaller cross-sectional area of median nerve at hamate level compared to radioulnar level correlates with slower (late) NCV findings. MRI may be able to detect early denervation of muscle as well as renervation. MRI's ability to visualize the extent of space-occupying lesions, signal changes related to denervated and fat infiltrated muscle, diverticulum, and other anatomical change may help clarify diagnosis and disease severity. [32, 33]

Diagnostic Ultrasonography (US)

- Diagnostic ultrasound was reported to have acceptable accuracy (sensitivity 88.4% and specificity 46.2%; $p<0.016$) in comparison to clinical criteria (see NCV section above). Because US interpretation is subject to greater qualitative interpretation, NCV/EMG was considered the best first-line confirming diagnostic test. [27]
- In a case control study of 95 patients, ultrasonography and MRI where recorded in both rest and grasp positions. Ultrasound can be an adequate tool for diagnosing CTS by combining the cross-sectional area of the median nerve in the rest position and the bowing of the flexor retinaculum in the grasp position. Though ultrasound was found to be adequate in diagnosing CTS, MRI is still the gold standard. [34]

PROGNOSTIC AND MANAGEMENT ISSUES

Prognostic Indicators

- A paresthesia score <6 nights PLUS < 1 year complaint duration correlate with greater success with splinting (moderate positive predictive value of 78%). [35]
- Less nerve involvement on NCV may predict greater success with conservative care; shorter duration of symptoms tends to yield better outcomes (but was not significant); younger age & relief of symptoms beginning within 5 months predicts better success. [26]

Progress Assessment & Functional Ability

Meaningful, measurable improvement (compared to baseline levels) is expected in the following areas within 6-8 weeks following onset of conservative treatment:

- Increase duration of work activity without symptom onset
- Decreased incidence and severity of nocturnal symptoms
- Reduction in symptomatic areas of hand diagram
- Less hypalgesia (increased sensitivity to sharp stimulus) in palmar surface of index finger
- Tip pinch grip strength and thumb abduction strength may have potential to evaluate improvement but should not be used in isolation

Splinting alone has been shown to lead to improvement within 5-36 months across different studies. Studies adding other conservative intervention appear to document improvements within 1-2 months. [26, 35, 36]

WORKERS' COMPENSATION ASSESSMENT ISSUES

Causation & Work Relatedness

- Likely work exposures typically involve: Medium to high force gripping and repetition, extreme prolonged end-range wrist flexion, extension, or deviation, sustained vibration, intermittent low force & repetition. (See Case Definition above). [37]
- Exceptionally clear medical justification for specific work exposure(s) is essential for fair and timely decisions. Delayed adjudication and development of adversity in work-related carpal tunnel cases has been associated with poor outcomes. Disability

	from CTS in Washington workers may be related more towards non-clinical factors (e.g., delays, adversity) than to clinical ones (e.g. severity). Other factors that may indicate increase risk of long term disability include activity intolerance, fear of re-injury and low recovery expectation. [38, 39] • In Washington State, occupational conditions that may be a result of cumulative workplace exposure across multiple employers may have claim and experience costs apportioned to both former and current employers. Worker and employer appeals rights can factor into adjudication decisions and contribute to delays which are associated with worse outcomes. [5, 40]
Early Accepted Diagnosis of CTS Claim	• CTS diagnosis occurring months after claim filing has been shown to be associated with additional medical problems and longer disability periods. For better outcomes, early definitive diagnosis is needed. [41]
Assessment of Re-exposure on RTW	• No studies were identified with current search strategies.
Physical capacity/Work restrictions	• Re-exposure to repetitive movement and heavy manual handling following CTS surgery correlates with longer period before return-to-work.[42]

CTS CONSERVATIVE INTERVENTIONS SUMMARY

Conservative CTS* Intervention Strategy *See CTS case definition on CTS Assessment Elements	Many individuals with carpal tunnel syndrome (CTS) continue to work with the condition and between 30-70% of patients will respond well to non-surgical interventions (compared to >70% full resolution with surgery, with highest proportion of good result with earlier diagnosis and surgery). Of concern for conservative interventions is rapid and sustainable relief. Findings of median nerve involvement on NCV strongly predict a good outcome with CTS surgery, therefore early acquisition of NCV should be routinely considered, particularly if CTS interferes with ability to work and/or meaningful improvement with conservative interventions is not evident within approximately 6-8 weeks of beginning care. Complications from prolonged disability can significantly outweigh other considerations. [26, 35, 41, 43-46] Various conservative interventions have been studied with nocturnal neutral splinting being the most rigorously studied, thus this should be central to any conservative treatment plan. Various combinations of other conservative interventions have also been studied mostly in lower quality studies and several appear to be comparable options when used with splinting. Among the conservative interventions most likely to be of additional benefit are carpal bone mobilization, systematic stretching exercise (e.g., yoga, nerve gliding), pulsed ultrasound. Most non-surgical interventions for carpal tunnel provide relief only in the short and moderate term. Oral and injected steroids have been shown to provide short term relief but half of patients treated this way undergo surgery within 1 year. [43, 45, 47-49] Overall, the non-surgical interventions such as splinting, exercise, and mobilization have limited, lower quality evidence of benefit for interventions for improving symptoms, functional ability (e.g. hand grip strength), quality of life, and neurophysiologic parameters, and for minimizing adverse effects and the need for surgery in people with carpal tunnel syndrome. The sustainability of these effects is not studied, particularly with regard to functional outcomes. [50, 51] Strong and moderate evidence was found for corticosteroids (oral or injection), and corticosteroid injection seems to be most effective. Ultrasound used as an intervention to treat CTS showed effectiveness in the short term and midterm.[45, 46]

- There is limited evidence for the effectiveness of exercises when compared to massage, adding breaks during computer work, massage as add-on treatment to manual therapy, manual therapy as add-on treatment to exercises, and ergonomic keyboards in people with carpal tunnel syndrome. For other interventions no clear effectiveness could be demonstrated.[46, 52]
- In a case series study, 150 participants with idiopathic carpal tunnel syndrome were divided into three groups by length of symptoms. Group 1 had surgery within 12 months of symptoms, group 2 within 12-24 months and group 3 more than 24 months of being symptomatic. All participants had unilateral or bilateral one-port endoscopic release of transverse carpal ligament. Surgery was found to produce excellent outcomes in all the groups with low risk and low morbidity. Early intervention groups showed the best post-operative outcomes.[53]
- A randomized trial comparing surgery to non-surgery in carpal tunnel syndrome had 116 participants (group 1; surgery N=57 and group 2; non-surgery N=59). Primary outcome measure was CTSAQ and secondary outcomes were hand wrist pain intensity/interference, SF-36 and lost work during prior month. Both surgical and non-surgical groups improved over 12 months, but patients assigned to surgery had significantly greater relief of symptoms and improvement in hand function by 6 months that persisted at 1 year. Improvement with patients assigned to non-surgical treatment was not as good.[54]
- A retrospective study of 120 patients self-selecting either surgery or non-surgical treatment explored the cost effectiveness of both approaches. Non-surgical interventions included physical therapy, splinting, and steroid injections (used on just 18 patiens). It did not differentiate between various physical approaches such as exercise and mobilization. The study matched patients based on available characteristics of age, gender, severity, NCV findings, as well as administrative factors such as insurance coverage. A cost utility ratio was calculated for direct costs of therapy concluding that non-surgical care averaged about $300 more than surgical care. Surgery is more cost effective in the long term for treating CTS patients.[55]

Splinting

Nocturnal splinting

- Custom-fitted neutral position splints worn at night and as needed for symptom control during the day provided complete or good (occasional minor symptoms) symptomatic relief and improved NCV at 5 months in 70% of patients.[26]
- Nocturnal-only neutral position splints provided long term success in 62% of patients who report less than 1 year's duration of CTS symptoms and nocturnal paresthesia less than 6 nights per week. Greater median nerve involvement on NCV predicts less benefit [35, 56]
- A small (21 subject with 17 completions) study randomized 24 electrodiagnostically confirmed hands into nocturnal and full time neutral splint use groups. Despite the limited sample, significant differences favored the full time user's sensory distal latency, symptom severity, and functional questionnaire measures at 6 week follow-up.[57]

Splinting strategies and positions

- A systematic Cochrane review identified 19 randomized or quasi-randomized controlled trials including 1190 participants with carpal tunnel. One low quality study suggests that splinting at night leads to more overall improvement in the short term when compared to no treatment, but did not conclude from the evidence whether one splint design or wearing regimen is more effective than another, nor that splinting is more effective than other non-surgical interventions (such as exercise or oral steroids). [47]
- In a case-control study of 120 patients with mild CTS, neutral splinting was found to provide symptom relief and neurophysiological improvement that lasted up to six months after follow up. [58]
- A single blind, randomized trial of 120 electrodiagnostically confirmed CTS patients into a group wearing a soft brace and a group wearing a nocturnal hard, neutral wrist splint compared BCTQ and VAS scores for pain and paresthesia. At 3 months both groups showed significant reduction in symptoms. At 9 months VAS pain reduction was greater in the nocturnal splint group with less evident reductions in BCTQ and paresthesia scores. [59]
- Intermittent splinting during work hours is commonly employed for symptomatic comfort for some people and as an ergonomic aid to prevent repetitive end range motion. There do not appear to be any well done trials for this in without the addition of nocturnal use. [26]
- Extension (cock-up) splinting of 20 degrees does not provide as much symptomatic relief as splinting in a neutral position. [60]

Wrist Manipulation & Mobilization	• A 21-subject trial that grouped subjects into 3 arms (carpal bone mobilization, median nerve region mobilization and no treatment control) reported statistically significant improvement in pain scores in both treatment groups over the control group but failed to show a difference in ROM and VAS to be statistically significant between the two treatment groups [61] • A 60-participant randomized trial assigned participants into standard occupational therapy care (nocturnal and heavy hand activity splinting and tendon gliding exercises) alone and standard care adding neurodynamic mobilization exercises. No significant difference between groups was reported for functional outcomes on two different hand function questionnaires (Carpal Tunnel Specific Questionnaire-Symptom Severity Scale and the DASH). [62] • In a case series study, four patients underwent intermittent wrist traction for five minutes over a three month period. All four patients demonstrated sustained 3 mo. & 1 yr. improvement in symptoms and normalization of the NCV. [63] • A randomized study of 91 subjects compared two multimodal conservative care approaches (forearm soft tissue & joint manipulation, cervical manipulation, ultrasound & nocturnal wrist splint vs. ibuprofen & nocturnal wrist splinting). Outcomes for self-reported physical/mental distress, NCV & vibrometry were equivalently improved in both groups after 9 weeks. [64] • No high quality studies have specifically compared extremity manipulation to other interventions for carpal tunnel syndrome, although various case studies have reported improvement in outcomes such as grip strength. [65]
Soft Tissue Techniques Massage, trigger point, passive stretch, etc.	• 12 sessions of massage targeted specifically to probable nerve entrapment sites was more effective than general relaxation massage (neck, back, upper extremities) in improving grip strength (sustainable 4 weeks after last Rx). Both groups demonstrated similar improvement on subjective tests. Selection criteria was unverified clinical diagnosis did not require NCV testing.[66] • In a small, non-randomized trial of 22 CTS patients, manual therapy was used as an intervention (2/week for 3 weeks). Patients were evaluated at 12 and 24 weeks. At 12 weeks, forearm pain and phalens test positivity were increased and hand strength reduced ($p<0.05$) compared to baseline. BCTQ scores improved At 12 weeks and ($P<0.05$) with amelioration maintained at 24 weeks compared to baseline. Other symptoms of CTS like paraesthesias, night awakening were reduced with lack of symptoms maintained at 24 weeks ($p<0.05$). Manual therapy improved CTS symptoms with benefits maintained at follow up. [67] • A randomized trial of 26 patients compared 10 treatments over 6 weeks of two types of soft tissue mobilization, instrument assisted soft tissue mobilization (Graston technique) with home stretching & strengthening exercise (n=14 with 2 dropouts) versus manual soft tissue and joint mobilization with home stretching and strengthening exercise (n=12 with 2 dropouts). Both groups demonstrated statistically significant improvement at the end of the treatment protocol and at 3 month follow-up compared to baseline scores on nerve conduction studies and self-reported symptom severity and hand function ratings. There was no statistical difference between groups.[68]
Exercise	Several types of hand and wrist exercises have been used to treat CTS, most prominently three kinds of mobilizing and stretching approaches: • **Nerve gliding exercises (NGE)** incorporate positional movements to stretch digits (individually and in groups) along with the wrist and forearm. Typically applied for a specified number of repetitions, the exercises theoretically traction the median nerve though the fascia along its course. Six positions include 1) neutral clenched fist; 2) neutral extended fingers and wrist; 3) extended fingers and wrist with thumb in neutral position; 4) wrist fingers and thumb in extended position; 5) wrist, fingers and thumb extended with wrist in fully supinated position; 6) wrist, fingers in neutral position with thumb passively stretched in abduction using opposite hand.[69] • **Tendon gliding exercises (TGE)** use active mobilization through full ranges of hand and finger motions aimed at enhancing tendon movement coursing through the wrist. Five discrete positions include 1) Straight - neutral wrist, fingers extended; 2) Hook – hand in neutral position with distal digits fully flexed; 3) Fist – fully closed position, all inter-phalangeal joints fully flexed; 4) Tabletop – wrist straight with fingers flexed only at the metacarpal-phalangeal joints; 5) Straight fist- wrist neutral with flexed metacarpal-phalangeal and proximal inter-phalangeal joints; distal inter-phalangeal joints extended. • **Generic stretching exercise** approaches such as yoga. • In a Taiwanese study, 53 patients were randomized into splint and paraffin; splint, paraffin and nerve glide exercise; splint, paraffin and tendon glide exercise. Following 2 months of treatment, only the tendon gliding group showed improved functional

status (measured on the DASH and the physical domain of the World Health Organization Quality of Life Brief Questionnaire).[34]

- In a prospective, randomized treatment trial from Turkey, 28 patients with CTS diagnosis in 36 hands were randomly assigned into two groups. Both groups wore neural volar splints at night but group 2 was instructed to also perform a series of nerve tendon gliding exercises in addition to splint treatment. At the end of treatment, improvement was slightly greater in group two, but the difference was not statically significant, except for lateral pinch strength (p=0.026).[69]
- A Turkish study compared NGE, volar splinting and activity modification to volar splinting and activity modification alone. Faster improvement and greater grip strength was reported with inclusion of nerve-gliding exercises. The study randomized 35 hands of 26 patients with electrodiagnostically confirmed CTS into the two groups who received 6 weeks of treatment. Both groups improved in clinical outcomes (pain, sensation, muscle strength, grip strength, pinch strength) and electrophysiologic measures. This study is limited by the small case size.[70]
- In a study of 197 patients with clinical symptoms of CTS (volar pain/paresthesia worse at night, positive Tinel, Phalens and 2-point discrimination) the addition of nerve gliding exercise to standard conservative care (splinting, oral and injected steroids, NSAIDs, PT at clinician discretion) reduced surgery rate. 43% of the group that included nerve gliding went on to surgery compared to 71% that did not perform exercise. Severe cases with thenar atrophy and those with concurrent conditions such as rheumatoid arthritis were excluded.[71]
- A Turkish trial compared 3 conservative interventions 1) splinting/NGE; 2) splinting/ultrasound; 3) splinting/NGE/ultrasound on 28 females (56 wrists) with electrodiagnostically confirmed bilateral CTS. Interventions were performed 5 times per week for 3 weeks. All 3 groups had significantly improved NCV findings, symptoms and exam findings which were sustained at 8 week follow up.[72]
- A single-blind randomized controlled trial examined and 8-week upper body yoga program on 42 individuals in two sites in Pennsylvania (a work site and a geriatric center).Subjects were recruited who met at least 2 of 5 clinical criteria for CTS (positive Tinel, Phalen, pain in median nerve distribution, sleep disturbance from hand symptoms, or numbness and paresthesia in median nerve distribution. 26 subjects were assigned to the yoga group and 25 to the control group (a neutral metal splint) 4 & 5 subject respectively did not complete the trial. The yoga group was reported to have statistically significant improvement in grip strength, pain, and Phalen sign compared to controls.[73]
- In a systematic review of randomized, quasi-randomized trials and non-randomized trials of work-related conditions concluded that there is limited evidence that exercise, particularly when individualized to the patient (rather than a group) may be more beneficial than massage for upper extremity complaints generally. Data was inadequate to differentiate between different types of exercise. [74]

Acupuncture

- A systematic review of six randomized controlled trials testing the effectiveness of acupuncture for CTS found no firm evidence that acupuncture was effective in the treatment of symptomatic CTS [75].
- A single center double blind RCT compared acupuncture with placebo acupuncture for the treatment of CTS; the study found that subjects in the acupuncture group had a 0.58 improvement (p=0.03) on the carpal tunnel self-assessment questionnaire symptom and function scale at 3 months after last treatment. Whereas 0.81 improvement (p=0.01) was noted in the placebo acupuncture group. No statistically significant difference was found between groups [76].
- Small RCT of Laser acupuncture vs. placebo (n=13/13) reported 30% improved night pain, no improvement in paresthesia or activity-associated pain. Inadequate statistical power Small RCT of Laser acupuncture versus placebo (n=13/13) reported 30% improved night pain, no improvement in paresthesia or activity-associated pain. Inadequate statistical power

Injected & Oral Steroids

Corticosteroids are in fairly common use for treating musculoskeletal pain, including CTS. Short term symptomatic relief has been demonstrated with steroids, but it is unclear if steroids provided sustained benefit in the long term.[43] Adverse events of long term steroid use cause this to not be recommended for more than 1-2 injections in the L&I CTS guideline.[6]

- Steroid injections have been shown to be effective in improving NCV and symptoms for mild to moderate cases. Comparison groups of phonphoresis and iontophoresis showed no improvements. 50% of treated patients have surgery within 1 year. [77]

- In a randomized clinical trial comparing surgical decompression and local steroid injection in the treatment of carpal tunnel, the results found that at a 2 year follow up, 60% of wrist in the injection group versus 69% in the surgery group reached a 20% response for nocturnal paraesthesias. The study concluded that local steroid injection and surgical decompression are effective treatments in alleviating primary CT symptoms. [78]
- A randomized control study aimed at comparing the effects of proximal and distal approach to the carpal tunnel regarding injection application, 19 patients with CTS were randomly assigned to either group i.e. proximal or distal. Measurements were collected at 3 weeks and 3 months after injection. All patients used hand wrist splinting during the 3 weeks after injection. There were significant reductions in pain and disability scores between baseline and follow up periods. There was no significant difference between groups. Though NCS showed that electrophysiology improvement slowed, there was an improvement in patient's global assessment from the distal injection group. An injection from the distal (palmar) was effective, comfortable and easy on minimizing symptoms. [79]
- One month of oral steroids was compared to one month of splinting in a randomized trial of 40 patients. Symptom severity scores and median nerve distal latency and conduction improved in both groups (no differences) at 1 month and was sustained at 3 months.[80]
- Proximal and distal injections of steroids were ineffective on the basis of both clinical symptoms and electrophysiologic findings. Improvement decreased over time. At 3 months, 34% of hands had symptom relief. At 6 months, 23% had improvement and 11% had improvement at 12 and 18 months.[81, 82]
- Several studies have reported that short term use (~4 weeks) of oral steroids significantly reduce CTS symptoms short term. NSAIDs, diuretics, vitamin B6 provide no better relief than placebos.[36, 83]

Physiotherapeutic Modalities

- **Ultrasound -** 11 randomized controlled trials including 443 participants overall assessed the safety and benefit of therapeutic ultrasound for people with carpal tunnel syndrome. There is only poor quality evidence from very limited data to suggest that therapeutic ultrasound may be more effective than placebo for either short- or long-term symptom improvement in people with carpal tunnel syndrome. There is insufficient evidence to support the greater benefit of one type of therapeutic ultrasound regimen over another or to support the use of therapeutic ultrasound as a treatment with greater efficacy compared with other nonsurgical interventions for carpal tunnel syndrome, such as splinting, exercises, and oral drugs. [84]
- **Phonphoresis -** A small double blind randomized controlled trial that assessed the efficacy of ultrasound versus ultrasound and ketoprofen phonophoresis in fifty one patients (76 median nerves) with clinical evidence of mild to moderate CTS. They were randomly assigned to 3 groups, group 1 received sham US and splinting, group 2 received US and splinting, group 3 received ketoprofen phonophoresis and splinting. An improvement was found in all parameters (VAS, FSS, SSS, mMDL and mSDL) for all groups at the end of the treatment and 8th week. It was found that pain score was significantly lower in group 3 compared to other treatment groups at 8th week according to ITT and PP analysis ($p = 0.002$, $p = 0.004$ and $p = 0.001$, $p = 0.001$). Ketoprofen PH as adjuvant therapy on splinting is effective with respect to reduction of pain. [85]
- **Low level laser therapy -** In a small (N= 11)randomized double blind study of mild to moderate CTS cases, low level laser therapy plus microamperes transcutaneous electric nerve stimulation (TENS) was applied to investigate pain reduction. Patients received real and sham treatment for 3-4 weeks. The outcome measure was McGill pain questionnaire (MPQ), sensory and motor latencies and Phalen and Tinel signs. Significant decrease in all outcome measures was found after treatment but not after sham series. Patients were able to return to previous work. [86] One high quality RCT comparing splinting in the neutral position with splinting plus sessions of low level laser therapy reported no significant difference between groups on the BCTQ [87].

WORKERS' COMPENSATION INTERVENTION ISSUES

Employer Contact for Accommodation

- Accommodation for modified work (administrative, ergonomic) may be primarily post-surgical consideration.[88]
- Early provider contact with employer to asses and establish needed accommodation may be associated with reduced long-term disability in occupational conditions generally. No analysis of CTS specifically. [89]

Care Coordination	• Washington State experience suggests that adoption of occupational health best practices, including timely diagnostics, assistance with coordination of care from resources within Centers of Occupational Health and Education can improve outcomes with CTS and other musculoskeletal conditions. [89]
Administrative Interventions Breaks, Duration, etc.	• Adding breaks to computer work are reported to provide benefit in reducing CTS symptoms compared to no breaks.[52]
Ergonomic Interventions Engineering Interventions, Work Site Modification, Multiple Component Interventions, etc.	• In a systematic review of randomized, quasi-randomized trials and non-randomized trials of work-related arm, neck and shoulder conditions, force displacement keyboards, or alternative geometry keyboards appear to be of limited benefit for symptom improvement. Other modifications have not been shown to provide benefit in reducing CTS symptoms.[52] • Breaks during computer work appear to have limited evidence for effectiveness in reducing symptoms associated with work-related arm, neck and shoulder conditions. [52] • Alternative keyboard designs & keypad configurations may offer improved comfort but have no impact in preventing CTS. [90] • Multiple component interventions (plant-wide workstation redesign, establishment of an ergonomics task force, job rotation, ergo training, and restricted duty provisions) have been shown to reduce work-related musculoskeletal disorders (WRMSD) in some studies, with direct employee involvement in job redesign potentially increasing the benefit. [52]
Conditioning & Work Hardening Interventions	• Work hardening for CTS has been associated with 83% return-to-work following treatment; 90% of these patients reported working with pain.[91] • Multidisciplinary occupational rehabilitation program (physical and work conditioning, work and stress management, workplace ergonomic counseling). Multidisciplinary program group had a significant increase in cases returned to work (74% vs. 40%) and who returned full-time (91% vs. 50%) compared to usual care PCP & physical medicine- PT/OT, DC, etc.). [92]
Return-to-Work Assistance	If a worker has difficulty in returning to work, return to work assistance may be helpful to address some factors. Longer temporary disability periods have been reported with the following: • Lower work-demand predicts more successful return to work following surgery [93] • Strenuous hand/wrist activity on RTW [88, 94, 95]. • Twisting end range exposure pre-op [96]. • Low mental health status; high pre-op absence, persistent post op symptoms [88]. • Female gender [96]. • Long term absence associated with psychosocial factors such as low pay, high job stress, low co-worker support, job-insecurity, low employer support [95, 97]. • Fear avoidance, low recovery expectation. [39] A study on the determinant of return to work after carpal tunnel release is job type, but psychological factors such as patient expectations, and catastrophic thinking, and anxiety in response to pain also have a role. 95, 98
Personal Controls	Separately implemented personal controls (e.g., WRMSD education, flexible splint use, EMG biofeedback, on-site exercise program)

Ergonomics Training, Splint Wearing, EMG Biofeedback, On-The-Job Exercise Programs, etc.	appear to be of no benefit in preventing CTS. Authors suggested that the combination of these controls with either engineering or administrative interventions may be more successful. [90]
Workflow/task Modifications	There is abundant literature opinion on various work flow modifications, but well done studies demonstrating clinical benefit or reductions in CTS incidence were not identified with the current search strategy.
Documentation of Progress	Symptom distribution using hand diagram and tip pinch strength should be re-assessed at approximately 2-4 week intervals. Improvement in symptom onset, duration, nocturnal paraesthesias, pinch strength, ability to work, ability to reduce dependency on splints and passive care should be strongly evident within the first 8 weeks of care. If not, consideration is warranted for EDS and specialty consultation.

Electrodiagnostic Testing

Nerve Conduction Velocity (NCV) – Findings corroborative of a CTS diagnosis: [29, 99-103]

Median motor distal latency (8cm) Note: If median motor distal latency is abnormal, then ulnar motor distal latency at 8 cm must be within normal limits (WNL) (≤ 3.9 msec).	< 4.5 msec
Median sensory distal latency	
8 cm recorded (palm to wrist) OR	< 2.3 msec
14 cm recorded (index, long, or ring finger to wrist) If either of these tests is used alone, at least one other sensory nerve in the ipsilateral hand should be normal.	< 3.6 msec
Median – ulnar motor latency difference (APB v. ADM) at 8cm	< 1.6 msec
Median – ulnar sensory latency difference to digits (14 cm) Index or long finger compared to ulnar recorded at the small finger, or – median-ulnar difference recorded at the ring finger	< 0.5 msec
Median-ulnar sensory latency difference across the palm (8cm)	< 0.3 msec
Median-radial sensory latency difference to the thumb (10 cm)	< 0.6 msec
Combined Sensory Index CSI is calculated by adding the 3 latency *differences* above: CSI = (median latency at 14cm – ulnar latency at 14cm) + (median latency at 8cm across palm – ulnar latency at 8cm across palm) + (median latency to thumb at 10cm – radial latency to thumb at 10cm)13 14	< 0.9 msec

Needle Electromyography (EMG) – Needle EMG may sometimes have a role in electrodiagnostic evaluation (surface/non-needle EMGs are not covered):

- Nerve conduction studies consistent with CTS, with wasting or substantial thenar weakness; or median motor nerve conduction study is significantly abnormal
- Suspected alternate diagnosis or comorbidity (e.g., diabetes)
- Acute crush injury or other major trauma to the distal upper extremity
- Proximal symptoms (e.g., neck stiffness, radiating pain) suggesting cervical radiculopathy.

Quantitative Sensory Testing (QST) – QST is not covered in Washington workers' compensation. Sensory function (vibration, temperature, pressure) may be useful in investigational settings to differentiate between patients with and without neuropathy. However, QST cannot localize peripheral nerve lesions and is not diagnostic for evaluating specific entrapment neuropathies. [104]

Progress Questionairres – Implementation & Scoring Instructions

Functional status assessment is critical for quantifying response to treatment. Because surgical care is so effective early, it is important to closely monitor functional improvement when a trial of conservative care is utilized. Functional questionnaires should be administered at baseline, then every 2-4 weeks. Scores should reduce over time. Clinically meaningful changes are indicated for each instrument.

Katz Hand Diagram – This tool has been validated for diagnostic purposes, but not for progress assessment. It does offer a graphic approach for illustrating if symptom distribution is changing.

QuickDASH – Highly used questionnaire for upper extremity function including several domains relevant to hand function commonly impacted with CTS. Two components are scored separately:

- ***Disability Section*** (11 items scored 1-5). At least 10 of the items must be answered to score the test. Responses are summed and averaged to produce a score out of 5 possible. The value is transformed to a score out of 100 (to simplify comparisons) by subtracting 1 and multiplying by 25.
- ***Work Section*** There are two optional versions of work and high performance (4 items scored 1-5). All completed responses are summed and divided by 4, then multiplied by 25.

Meaningful change: Minimal clinically important difference has been reported to be 19 points with minimal detectable change being 11 points.

Carpal Tunnel Syndrome Assessment Questionnaire (CTSAQ, aka Boston Carpal Tunnel Questionnaire) – CTS specific 11 item questionnaire validated in clinical and research setting for tracking progress. Each question is scored 0-4 and totaled (for a maximum of 44). Larger score indicate greater severity.

Michigan Hand Questionnaire – Extensive validated CTS specific questionnaire that is used primarily in research settings due to its length. A shorter 12-item version is available with complete scoring instructions at http://sitemaker.umich.edu/mhq/brief_mhq.

Intervention/Experimental Studies

Randomized Controlled Trial (RCT) – A study that randomly allocates patients to treatment groups, usually blinding patients, therapists and/or study evaluators. Typically of high quality as randomization assures similarities of subjects within treatment groups.

Observational Studies

Cohort Design – Cohort (retrospective or prospective) – A study that follows patients who self-allocate to treatment groups through the course of their care for a given occurrence of a condition. Larger, well-designed cohort studies may be of good quality, but lack of randomization predisposes to heterogeneity issues within groups, some of which may be able to be adjusted for with statistical methods.

Cross sectional – Involves observing a population to measure disease and exposure status. It is usually thought to be a "snapshot" of the frequency and characteristics of a disease in a population at a specific given time.

Case control – Is a study that compares patients who have an outcome (cases) of interest with patients who do not have the disease or outcome (controls). The study may retrospectively compare how frequently the exposure was present in a group to determine risk factors.

Case series – Is a study that describes a series of patients with an outcome of interest, may be of variable quality. Better designs use consecutive patients and include robust baseline and follow up outcome measures.

Case reports – Describes an individual case, typically only achieving publication if it represent a unique or unusual clinical experience.

Blinding

Blinding minimizes potential bias. Typically three levels of blinding are sought: patient, treating provider and evaluator. Many conservative interventions do not allow for patient blinding (e.g. someone is likely to know if they received a splint or a pill). At a minimum, single blinding of the evaluator as to what group a subject was in is expected.

Literature Reviews

Quantitative systematic reviews – Studies that review previously published clinical trials that include quantitative comparisons (e.g. meta-analyses). Systematic reviews should have rigorous and comprehensive methodology to identify relevant published research and include appraisal of study quality. Cochrane reviews frequently are of this type.

Qualitative systematic reviews – Similar to quantitative reviews but without systematic quantitative comparison or data pooling.

Narrative literature reviews – Such reviews typically do not include rigorous study selection methodology and may be subject to significant author bias

Literature Retrieval and Review

1. **Initial systematic searches** of electronic databases (e.g. PubMed). Search terms used typically included MeSH terms for tests and interventions with conditions being addressed. Follow-up searches also included population attributes (e.g., workers compensation, occupational).
2. **Abstract screening** for relevance.
3. **Original paper retrieval** with review for relevance, quality, outcome meaningfulness, and effect magnitude.
4. **Additional studies identified** through clinical summaries (e.g., reviews, texts), citation tracking, and feedback from public.

About Evidence for Physical Examination and Conservative Interventions

Conservative musculoskeletal care is typically care of first resort based on long standing practices. Typically 'low tech,' low cost, with minimal and rare side effects, it is frequently delivered in primary care settings, and by various health providers. The rigor and quality expected of high cost, higher risk, emerging, and tertiary interventions is less common for many routine physical examination procedures and conservative interventions. Much of the evidence summarized here would be considered Class "C" or "III" in ratings systems. Thus, the committee has not presented explicit *recommendations*, rather, *evidence summaries* guided by expert consensus to assist in formulating care options. Further, significant emphasis is made regarding tracking and documenting meaningful functional improvement with patients. Study attributes most likely to strengthen or limit confidence are characterized in the evidence descriptions.

Assessing Study Methodologic Quality

Attributes of study methodology quality vary according to the clinical procedure (eg, diagnostic, therapeutic intervention) looked at, and specific research questions being studied. The American Academy of Neurology's Clinical Practice Guideline Process Manual [105] offers a comprehensive guide to systematic evidence review, quality attributes and consensus process that generally serves as the approach taken by IICAC.

General attributes identified when extracting evidence from studies include identification of population, the intervention and co-interventions and outcomes being addressed in each study. The clinical questions addressed such as diagnostic accuracy, therapeutic effectiveness, or causation are determined. Studies are extracted into evidence tables including quality attributes and/or ratings which are reviewed both by department staff and committee members (usually 2 per study).

Specific quality attributes include: Diagnostic Accuracy – design, spectrum of patients, validity and relevance of outcome metric; Therapeutic Interventions – comparison groups (no treatment, placebo, comparative intervention), treatment allocation, blinding/masking (method and degree: single, double, independent), follow-up (period and completion), and analysis (statistical power, intent-to-treat). Specific attention is paid to several factors including reporting of outcomes (primary vs. secondary), relevance of outcome (e.g., function versus pain), and meaningfulness (clinically important change versus minimally detectable change).

Synthesizing Evidence

Consideration of study quality (class), significance (statistical precision), consistency across studies, magnitude of effect, and relevance to populations and procedures were taken into account in preparing draft summaries. Special attention was given to clarifying conclusions related to the clinical questions of interest. Evidence, particularly with low tech and highly diffused examination and conservative procedures addressed here, is rarely truly "definitive," even when multiple studies exist. Inconsistent conclusions typically reflect error (systematic, random) and/or bias in studies. Data pooling via meta-analysis is useful to reduce random error when studies are of sufficient power and methodologic strength. Larger meaningful effect size may increases confidence in findings.

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