



## **Standard of Care: Carpal Tunnel Syndrome**

### **Case Type / Diagnosis**

Carpal tunnel syndrome (CTS) is certainly the most common and frequently diagnosed nerve entrapment. For this standard of care, CTS is defined as the symptoms manifested when the median nerve, the major sensory and motor nerve of the hand, becomes compressed as it travels from the forearm to the hand through the carpal tunnel. To best understand this syndrome, the anatomy of the carpal tunnel and the median nerve, along with the factors that lead to median nerve compression should be well understood.

### **Anatomy:**

The Carpal tunnel is a canal formed by bone and ligamentous borders at the wrist, through which the nine-flexor tendons (4 flexor digitorum profundus, 4 flexor digitorum superficialis, and the flexor pollicis longus) and the median nerve pass. The floor of this tunnel is an arch formed by the carpal bones, the top of the tunnel is known as the flexor retinaculum, or the transverse carpal ligament. Radially, this ligament attaches on the scaphoid tuberosity and the trapezium, and to the pisiform and the hook of the hamate on the ulnar side. In a healthy tunnel, the synovial sheaths surrounding the tendons act as protective padding for the median nerve as it travels through the canal. However, as the demands of the tendons increase with activities of daily living, this protective cushion can become more fibrous in nature, which made lead to entrapment, and or crushing of the median nerve.

The median nerve's distribution in the hand is also important to understand, as this may have a direct correlation to the patient's symptoms. After exiting the carpal tunnel, the median nerve divides into five digital branches. The motor branches supply the thenar musculature, and the 1<sup>st</sup> and 2<sup>nd</sup> lumbricales. The other branches are sensory, and supply sensation to the thumb, 2nd and 3rd digit, and the radial ½ of the fourth digit.

### **Symptom Presentation:**

Patients with CTS often describe numbness rather than pain to the median nerve distribution consistent with the compression of the median nerve. A clinician should be aware however, that some patients would complain of dysesthesia of the entire hand and not just the thumb, index, middle, and radial half of the fourth digit. This is due to the possibility of variable innervations of the median nerve, as well as the patient's subjective difficulty interpreting these symptoms. <sup>1</sup>Patients typically report sleep disturbances due to nocturnal paresthesias or burning pain that may occur from flexed positioning of wrists during sleep. As this condition progresses, patients may feel tingling during functional and or occupational activities during the day. Decreased grip

## **Standard of Care: Carpal Tunnel Syndrome**

strength is a typical complaint, and may make it difficult to form a fist, grasp small objects, or perform other manual tasks.

In chronic and or untreated cases, the thenar muscles will begin to atrophy, as they lose innervations from the median nerve. Motor symptoms, that is, loss of thumb opposition and abduction, as well as thenar atrophy generally appear late in the course of CTS. <sup>2</sup>Sensory testing may demonstrate diminished or absent of tactile sensation. For example, a patient may not be able to tell the difference between hot and cold by touch of the affected hand.

### **Causes of Carpal Tunnel Syndrome:**

CTS is caused by factors that increase pressure on the median nerve, causing entrapment of the nerve, or in extreme cases, ischemia of the median nerve. The most common cause of CTS is an idiopathic nonspecific flexor tenosynovitis that may simply arise from chronic repetitive occupational stress. <sup>3</sup> Other contributing factors include trauma or injury to the ipsilateral upper extremity that causes edema. Individuals with diabetes or other metabolic disorders such as over activity of the pituitary gland and hypothyroidism are more susceptible to compression. Mechanical problems in the wrist joint, work stress, repeated use of vibrating hand tools could lead to nerve compression. The presence of rheumatoid arthritis could lead to alterations of the bony margins of the carpal tunnel. The development of a cyst or tumor in the tunnel could also lead to nerve compression.

### **Demographics:**

It is interesting to note that women between 40 and 60 years of age are three times more likely than men to develop CTS. <sup>3</sup> This could be because the tunnel itself maybe smaller in women than in men. This also may be due to fluid retention during pregnancy or menopause. The dominant hand is usually affected first and produces the most severe symptoms. <sup>4</sup> CTS usually occurs only in adults.

### **Indications for Treatment:**

Patients who are referred to therapy generally report symptoms of CTS as described above. The clinician must listen and observe all of the patient's descriptions of paresthesias and/or motor loss to the hand, as they will assist in a guide to evaluation, conservative treatment, and prognosis. For example, if a patient is describing signs of significant nerve damage, (see below) prognosis regardless of treatment, will be poor.

Below are common symptoms, which generally have good prognosis with a course of conservative treatment of CTS.

### **Standard of Care: Carpal Tunnel Syndrome**

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- Paresthesias in the median nerve distribution of the hand, these symptoms may only occur at night, or sporadically during the day, especially after repetitive forceful hand motion.
- Mild symptoms of weakness or patient's report of clumsiness to the hand, as described by frequent dropping of items, or decreased ability to manipulate small objects.
- Pain, often described as "burning" to the hand and thenar region, which can also spread above wrist into the forearm, and less commonly to the upper arm.
- Sensory abnormalities usually occur in the first stages of median nerve compression, and reports of numbness and or tingling without other symptoms should be a sign of a good prognosis for the patient.<sup>3</sup>

### **Contraindications / Precautions for Treatment:**

Patients who are referred to therapy with the below symptoms typically have a poor prognosis for conservative treatment, as increasingly severe deficits noted during clinical observations are proportional to the degree of nerve damage and the duration of compression.

- Pronounced thenar muscle atrophy
- Loss of finger dexterity
- Semmes-Weinstein mono-filament testing is + for "loss of protective sensation" or "absent sensation" (Please refer to Sensory SOC for description of Semmes-Weinstein test)
- Loss of two-point discrimination (Please refer to Sensory SOC for description of Two-point discrimination test)
- Severe pain (> 8/10 on the patient pain analog scale)
- Patients who cannot tolerate NSAIDs may progress more slowly due to the inability to sufficiently manage inflammatory conditions.
- It is also important to consider a patient's ability to provide an accurate history of symptoms, and the ability to carry over education, written programs and directions to the home and occupational environments.
- The referring physician should be contacted if the patient's neurological symptoms continue to worsen or not respond to conservative treatment despite compliance with the treatment plan.

### **Standard of Care: Carpal Tunnel Syndrome**

**Examination:****Medical History:**

The clinician should carefully review a patient's medical history questionnaire (on an ambulatory evaluation), patient's medical record, and medical history reported in the hospital's computerized medical record. A clinician should review any diagnostic testing results, or imaging also found in the computerized record. Careful consideration should be made to identify any traumatic history to the affected extremity, rheumatoid illnesses, diabetes or other metabolic disorders. Finally, the clinician should review any diagnostic tests and work-ups. Especially helpful would be reports from electromyographic testing if available. This test would note the presence and severity of nerve compression.

**History of Present Illness:**

The importance of obtaining a clear understanding of the patient's symptom history should not be underestimated. A careful and detailed history is very revealing and can be more useful than the objective clinical examination (which can be normal in the early stages of CTS). The clinician should obtain information on the timeline of onset and development of the symptoms. The clinician should identify with the patient any provocative vs. relieving activities, and other behavior of the symptoms.

**Medications:**

The patient may be on NSAIDS (nonsteroidal anti-inflammatory drugs), as they are the medication of choice for decreasing inflammation, and soft tissue swelling leading to nerve compression. Corticosteroids can be injected directly into the wrist by an MD, and are provided to relieve pressure on the median nerve. This will usually provide immediate, temporary relief to persons with mild or intermittent symptoms.

**Social History:**

Review of a patient's home, work, recreational activities. Information should be obtained on patient's prior functional and present functional levels on these tasks. A clinician should identify repetitive and/or resistive motions involving the wrist, as well as digital flexion and extension during a patient's daily activities. It is also of important to identify poor body mechanics and posture present during daily activities.

**Examination** (Physical / Cognitive / applicable tests and measures / other)

This section is intended to capture the minimum data set and identify specific circumstance(s) that might require additional tests and measures.

**Physical Examination****Standard of Care: Carpal Tunnel Syndrome**

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**Pain:** As measured on the VAS (Visual Analog Scale). Specify location of pain, activities that increase pain and/or decreased pain.

1. **Pain – Place**
2. **Amount – Pain level VAS (0-10)**
3. **Intensifiers**
4. **Nullifiers**
5. **Effect on Function**
6. **Descriptors (i.e. sharp, dull, constant, throbbing, etc.)**

**Sensation:** A patient with CTS may demonstrate decreased sensation in the median nerve distribution of the hand. The severity of diminished sensation, or if there is a decline at all, is not a definite indicator of CTS, and can only contribute to the over all clinical presentation. A Semmes-Weinstein monofilament test is an accurate and objectively measurable test for sensory deficits in the hand. The Semmes-Weinstein can be a predictor of the quality of neural return, or the severity of diminution.<sup>6</sup> Please refer to the Sensation SOC for a description, and instructions for the administration of the test.

**Edema:** To note for objective differences in widths, measurements should be taken to distal B UE. Widths to be measured on documented landmarks, usually the distal wrist at the distal palmer crease, and recorded as circumferential measurements, in centimeters. In the absence of gross deformities, increases in width may show increased edema to carpal location and increase probability of median nerve compression.

**Active and Passive Range of Motion: (A/PROM):** Measure distal bilateral (B) upper extremity (UE) range of motion, (Elbow, forearm, wrist, thumb, digits) noting limitations to range due to pain, and or onset of parathesias. Of note, for most mild to moderate CTS patients, A/PROM is expected to be within normal ranges. As the compression progresses, intrinsic muscles, such as the abductor pollicis brevis, flexor pollicis brevis, the opponens pollicis, and the adductor pollicis may weaken to the point that thumb opposition declines.<sup>5</sup>

**MMT/Strength testing:** Specific MMT for the abductor pollicis brevis, which is the most radial and superficial of the thenar muscles, is usually completed on evaluation. This muscle is the first to atrophy with median nerve dysfunction, such as that resulting from long-standing CTS.<sup>5</sup> The abductor pollicis brevis can be tested by having the patient perform palmer abduction while the examiner palpates the muscle. Thumb opposition strength can also be tested by having the patient demonstrate the “OK” position of thumb and index finger, then attempt to spread the thumb and index apart with your fingers in-between.

Strength testing for general grip and pinch strengths can be done by the use of a calibrated dynamometer and a calibrated pinch gauge. Both tests are completed by having the patient squeeze and/or pinch as hard as possible, alternating between hands, and taking the average from

## **Standard of Care: Carpal Tunnel Syndrome**

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three trials. The pinch gauge can measure 3 point as well as lateral pinches. In most cases of mild to moderate CTS the effected hand will demonstrate lowered scores than the non-affected hand.

**Functional Assessment:** The use of a specific functional capacity questionnaire is recommended to establish current functional deficits, assist in establishing goals, and to track progress.

Possible tools:

- Michigan Hand Questionnaire
- Manual Ability Measure

**Special Tests:** The two best-known provocative tests used in a CTS diagnosis are Phalen's sign and Tinel's sign.

- Phalen's sign; Also called the wrist-flexion test, the test is performed by having the patient drop both wrists into flexion, fingers and thumbs extended for 60 seconds. A positive sign includes numbness and paresthasias in the median nerve distribution within 60 seconds of sustained flexion.<sup>7</sup>
- Tinel's sign: The Tinel's test is performed with a light percussion of the Median nerve at the wrist. A positive Tinel's sign includes tingling and paresthasias over the median nerve distribution.<sup>7</sup>

**Acute (Inpatient (if applicable):**

As Above

**Sub-Acute (Outpatient) (if applicable):**

As Above

**Differential Diagnosis (if applicable):**

While CTS is certainly the most common of the neuropathies to occur in the upper extremity, it is important to note other common compression neuropathies that can at times mimic CTS.

- C6 RADICULOPATHY: C6 Radiculopathy caused by cervical spondylosis most commonly occurs in middle-aged or elderly patients and is the root with the greatest degree of nearly identical symptoms to those of median nerve compression.<sup>3</sup> Common symptoms associated with C6 radiculopathy , that do not occur in CTS include: Neck and shoulder pain, especially when they occur with concurrent coughing or sneezing. Similarly, back pain, located at the medial border of the scapula is characteristic of a radiculopathy, and is not expected in CTS. Night pain, a common complaint of a patient

6

**Standard of Care: Carpal Tunnel Syndrome**

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with CTS, does not occur with a patient suffering from radiculopathy, daytime pain with arm use is the usual complaint. If the sixth cervical nerve is affected, there may be weakness of elbow flexion and wrist extension, the biceps reflex may be lost or reduced, and electromyographic (EMG) studies will show denervation out of median nerve territory if the cause of the disorder is cervical nerve root damage.<sup>3</sup> Finally, utilizing the Semmes-Weinstein sensory test, the clinician would note a sensory loss of the C6 dermatome (thumb and lateral boarder of the upper extremity running to the neck), rather than the expected loss at the thumb, index, middle and radial half of the 4<sup>th</sup> digit. For further information regarding C6 radiculopathy, please refer to the radiculopathy standard of care.

- **PRONATOR SYNDROME:** Also a syndrome resulting from a compression of the medial nerve, the differences in symptoms are due in part to the site of compression. In pronator syndrome, the medial nerve becomes compressed as it passes by the pronator muscle, and the insertion of the deep flexor muscles at the elbow joint. With this syndrome, sensory loss will mimic that of CTS, however, there are several differences between the two diagnoses. The pronator syndrome is distinguished by exacerbation attributable to resisted pronation and passive supination activities, positive Tinel's sign at the proximal forearm overlying the median nerve, tenderness and paresthesias in the median nerve distribution on direct compression over pronator muscle, and pain and median nerve paresthesias with forced pronation, as well as passive supination at the limit of full elbow extension.<sup>3</sup> Symptoms brought on by wrist movements, a hallmark of CTS are not common with pronator syndrome.
- **RAYNAUD'S DISEASE:** The symptoms caused by local vasospasm are differentiated from CTS in the sense that Raynaud's phenomenon does not involve any distinction between the fingers, with all the fingers and palm being equally affected.<sup>3</sup> Diminished circulation symptoms such as color blanching at the digits, and cool to the touch temperature of the hand can be observed on a patient with Raynaud's, while they are not observed in patients with CTS.
- **CUBITAL TUNNEL SYNDROME:** Cubital tunnel syndrome is an ulnar nerve compression neuropathy resulting from acute or chronic external pressure on the ulnar nerve as it passes through the cubital tunnel during its course from the arm to the forearm.<sup>8</sup> The cubital tunnel is formed by the condylar groove between the medial epicondyle of the humerus and the olecranon of the ulna.<sup>8</sup> The symptoms of ulnar nerve compression will be quite different from ones caused by median nerve compression. Patients will usually describe a sharp or aching pain on the medial side the elbow, hand pain is not as common as it is in CTS. Sensory loss will be felt at the ring and small fingers, motor loss will be seen by atrophy of the 3<sup>rd</sup> and 4<sup>th</sup> lumbrical muscles. A more recognizable clinical feature is atrophy of the intrinsic muscles with clawing of the ring and little fingers.<sup>8</sup> Special testing for cubital tunnel would include:

## **Standard of Care: Carpal Tunnel Syndrome**

1. Tinel's sign: The Tinel's test is performed with a light percussion of the ulnar nerve at the cubital tunnel. A positive Tinel's sign includes tingling and paresthesias over the ulnar nerve distribution.
2. Elbow flexion test of Wadsworth: <sup>8</sup> This test is performed by having the patient hold elbows in full flexion, with wrists held in extension. This position will increase pressures within the cubital canal. A positive test includes tingling and paresthesias over the ulnar nerve distribution. For further information regarding cubital tunnel syndrome, please refer to the cubital tunnel syndrome standard of care.

### **Evaluation / Assessment:**

#### **Establish Diagnosis and Need for Skilled Services**

Patients diagnosed with CTS will benefit from conservative treatment with therapy to assist in minimizing impairments, improving functional status, and reduce the need for surgical intervention.

Potential Problem List (Identify Impairment(s) and/ or dysfunction(s)):

- Pain to affective hand
- Paresthesias: numbness and/or tingling, which can impair the patient's fine motor control of affected digits
- Declined grip and/or pinch strength to affected hand
- Declined endurance of affective hand for repetitive activity
- Declined functional use of affective hand for ADL tasks
- Declined knowledge of ergonomic education, proper body mechanics and joint protection during ADL's, and in the work environment

#### **Prognosis**

Clinical practice suggests that patients will have different outcomes in terms of pain relief and sensory return, strength and function. For the purposes of this standard, relevant clinical improvement is defined as significant relief of pain and paraesthesia by at least 50% of the baseline level, or the improvement of muscle weakness resulting in improvement in quality of life and functional status. <sup>9</sup> It is difficult to make definitive conclusions about the outcomes of conservative interventions for CTS due to variations in outcome measures, the severity of CTS and inconsistencies in duration, type of intervention, and follow-up time for interventions. <sup>10</sup> It is of interest to note, that the conclusions to multiple studies into the effects of conservative interventions, all tend to lead to the conclusion that surgical treatment of CTS relieves symptoms better than conservative interventions on patients with overt symptoms. <sup>9</sup> With this in mind, if symptoms are not adequately improved, or if symptoms are worsening as noted by patient's

#### **Standard of Care: Carpal Tunnel Syndrome**

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subjective report, and therapist's objective measurements, then the therapist should report these findings back to the referring physician.

### **Goals**

- Goals will be measurable and reassessed every 30 days
- Goals will reflect individual patient's functional impairments in ADL's, leisure and/or work tasks
- Goals will include patient's ability to follow home program
- Goals to reflect patient's education of body mechanics and ergonomics, including the avoidance of provoking postures and activities.
- If splinting is involved in the treatment program, goals will reflect the patient's independence in their wearing schedule, and the care and hygiene of splints.

### **Age / Other Specific Considerations**

As previously described, women, especially between the ages of 40-60, are most likely to develop CTS. Therapists who are treating this patient population should consider degenerative joint diseases and other medical issues associated with aging.

Women who are pregnant are also at a higher risk for developing CTS. When treating this population, therapist should consider not only medical issues associated with pregnancy, but also specific life tasks such as child care. Breast feeding, lifting and/or carrying a newborn may place the affected upper extremity in provoking postures, and adaptations to these activities may be necessary.

The other large populations are adult workers whose occupations require repeated overuse activities should be considered. Occupational variants predisposing CTS may include carpentry, secretarial work, auto mechanics and construction workers.<sup>11</sup> Treatment with this population should include assessments and adaptations of such activities that place the extremity at risk for nerve entrapment at the wrist.

### **Treatment Planning / Interventions**

Established Pathway	<input type="checkbox"/> Yes, see attached.	<input checked="" type="checkbox"/> No
Established Protocol	<input type="checkbox"/> Yes, see attached.	<input checked="" type="checkbox"/> No

### **Standard of Care: Carpal Tunnel Syndrome**

## **Interventions**

*This section is intended to capture the most commonly used interventions for this case type/diagnosis. It is not intended to be either inclusive or exclusive of appropriate interventions.*

**Splinting:** Splinting of the wrist in the neutral position to 15 deg of extension is the initial intervention in the conservative treatment of CTS. Splinting the wrist in this position, places the carpal tunnel in its most open position, allowing for restoration of maximal circulation to the median nerve. Further compression to the median nerve with prolonged wrist flexion while sleeping, or during daily/occupational activities are prevented with the use of a wrist splint. Based on what is known to date, current treatment for patients with mild to moderate CTS recommend including a conservative program of splinting the wrist in neutral for nocturnal wear.<sup>10</sup> Typically pre-fabricated Velcro closed wrist splints are used. The occupational or physical therapist for the patient that is receiving therapy services typically fits this. (Please note: Patients with CTS may be referred for only a prefabricated splint for the management of their CTS. In this case the prefabricated splint is fit and applied by an orthopedic technician upon receipt of the prescription from the MD. Please refer to the prefabricated wrist splint standard of care for specific details.)

The wearing schedule of the splint is primarily recommended for nighttime use. Patients who are having complaints of constant symptoms, or who have pain and or sensory changes with activity are instructed to wear the splint at work or during highly resistive and repetitive motions. The patient is generally instructed to continue with the splint-wearing schedule for 4 to 6 weeks, and then gradually decrease splint use over the subsequent 4 weeks.<sup>12</sup> Workers identified with CTS symptom surveillance tended to benefit from a 6-week nocturnal splinting trial, and the benefits were still evident at the 1-year follow up.<sup>13</sup> Length of time for splint use may also be determined by the causes of the individual's CTS's and their response to treatment. For example, a patient demonstrating CTS symptoms during pregnancy may only require splinting during this time. Long-term use of a splint (greater than 2 months) may be indicated when other conservative measures have been exhausted, and the patient declines surgical or other medical intervention.

If a patient is unable to comfortably fit into a pre-fabricated splint, or if the correct wrist position cannot be achieved due to wrist deformity, or unusual wrist size, a custom orthoplast splint may be fabricated. Either an occupational therapist or physical therapist fabricates this custom splint for the patient. As with the pre-fabricated splint, the wrist should be placed in the neutral to 15 degrees of extension position. If a patient's symptoms do not positively respond to basic custom wrist splinting, recent studies have shown a benefit to extending the orthoplast splint distally to include the patient's metacarpophalangeal joints (MCP's) in extension. This splint immobilizes the MCP's and does not allow for the lumbrical muscles (intrinsic hand muscles responsible for MCP flexion) to rest within the tunnel.<sup>14</sup> The splint-wearing schedule for this splint would mimic the schedule for the wrist splint, however, the patient should be instructed to remove this splint periodically throughout the day for mobilization of the MCP's, and tendon gliding exercises (see below) to eliminate the possibility of creating joint stiffness.

10

## **Standard of Care: Carpal Tunnel Syndrome**

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**Ergonomic education:** Repetitiveness of work tasks, and poor posture during repetitive tasks are commonly cited risk factors for the development of CTS.<sup>14</sup> (As discussed above, during the assessment of these patients, occupational tasks and the patient's posture during these activities should be identified.) On going education should include avoidance of wrist postures (i.e., prolonged wrist flexion), repetitive wrist motions such as gripping or pinching objects while flexing the wrist, and performing repetitive wrist flexion-extension exercise motions.<sup>14</sup> It is important to evaluate the work environment and to suggest alternatives such as ergonomically designed workstations designed to limit postural stresses.

**Tendon-Gliding exercises:** Isolated tendon gliding exercises of the flexor digitorum superficialis and flexor digitorum profundus to each digit passing through the carpal tunnel has also shown to be effective in recent studies. The results of the study indicated a significant improvement in patients' carpal tunnel symptoms when tendon-gliding exercises were performed in conjunction with traditional treatment.<sup>14</sup> Each exercise series starts with the wrist and digits in full extension, then the digits are held in a hook grip, followed by a straight fist, followed by a full fist. These exercises are to be preformed five times each, five times daily.<sup>14</sup>

**Modalities:** Modalities such as Ultrasound, Fluidotherapy and Iontophoresis using dexamethasone have been used in the conservative treatment of CTS. Some studies support the use of iontophoresis, for example a study by Banta<sup>15</sup> used iontophoresis in conjunction with splinting and NSAIDs, and reported a success rate of 17% for patients with Mild CTS.<sup>14</sup> It should be noted however, that there are inconclusive findings to support or refute the efficacy of these modalities, and more research is required to determine the therapeutic effects of ultrasound and iontophoresis. These modalities should not be routinely initiated for patients with CTS, unless the patient's medical condition is problematic such that they have an NSAID intolerance and/or chooses not to take medication, etc....

### **Frequency & Duration**

- Frequency of hand therapy for the conservative management of CTS is 1-2x/wk for 6 weeks, or as indicated by patients' status and progression. Most patients should meet their clinical goals within 6 visits or 2 months of therapy depending upon severity of presenting signs and symptoms. Progression and improvement will be indicated by the achievement of established short-term goals, and the elimination of symptoms per patient reports and subjective testing.
- Duration of each treatment session is dictated by the patient's needs.

### **Patient / Family Education**

- Instruction of home program with verbal and written instructions
- Ergonomics, body mechanics, adaptive equipment and adaptations as needed during ADL's

### **Standard of Care: Carpal Tunnel Syndrome**

- Splint don/doff, wearing schedule and hygiene
- Education on CTS, basic anatomy and causes of compression

### **Recommendations and Referrals to Other Providers**

- Pt will be referred back to referring physician/surgeon should symptoms persist or worsen.

### **Re-evaluation / assessment**

Standard Time Frame

- Goals will be reassessed every 30 days

Other Possible Triggers

- A significant change in symptoms that has reduced patient's baseline functional level
- Discharge from therapy program

### **Discharge Planning**

Discharge planning begins at the initial evaluation of the patients as the treatment plan, prognosis and frequency are initiated.

### **Commonly Expected Outcomes at Discharge**

- Patient upon discharge from therapy should be independent with home program and have returned to there premorbid level of function
- Patient should demonstrate independence with adaptations and adaptive equipment during ADL's
- Patient should report resolution of paresthesias and/or pain to affected hand

### **Transfer of Care (if applicable)**

Should symptoms persist and/or increase, pt to be referred back to patients PCP or specialist who referred patient to therapy.

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### **Standard of Care: Carpal Tunnel Syndrome**

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## **Standard of Care: Carpal Tunnel Syndrome**

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