Complex Regional Pain Syndrome

Course Goals & Objectives

Course Description

Complex Regional Pain Syndrome is a text-based asynchronous online continuing education program for physical therapists and physical therapist assistants. The course presents contemporary information about complex regional pain syndrome including sections on epidemiology, etiology, symptomology, diagnosis, evaluation, treatment, and multidiscipline collaboration.

Course Rationale

The purpose of this course is to present contemporary information about complex regional pain syndrome to physical therapists and physical therapist assistants. Physical therapists and physical therapist assistants. will find this information pertinent and useful when developing and implementing rehabilitation programs that address the challenges and needs specific to individuals with CRPS.

Course Goals & Objectives
At the end of this course, the participants will be able to:
1. Identify the causative factors associated with CRPS
2. Recognize the symptomology and clinical signs of CRPS
3. Identify and define the criteria used to diagnose CRPS
4. Identify and outline the components of a comprehensive CRPS evaluation
5. Define the roles and responsibilities of a CRPS interdisciplinary treatment team
6. Identify and define the components of an effective CRPS rehabilitation program
7. Recognize and define commonly utilized invasive interventions for CRPS
8. Recognize and define commonly utilized non-invasive interventions for CRPS
9. List and define the alternative therapeutic options for treating CRPS

Course Provider – Innovative Educational Services

Course Instructor - Michael Niss, DPT

Target Audience – physical therapists and physical therapist assistants.

Course Educational Level – Introductory / intermediate

Course Prerequisites – None

Method of Instruction/Availability – Online text-based course available continuously.

Criteria for Issuance of CE Credits - A score of 70% or greater on the course post-test

Continuing Education Credits – 3 hours

Determination of Credits – Mergener Formula: .9 x [-22.3+(0.00209 x 64,247) + (2.78 x 15) + (15.5 x 3)] = 180 minutes = 3.0 hours/ 3 CE units

Fees - $29.95

Conflict of Interest – No conflict of interest exists for the presenter or provider of this course.

Refund Policy - Unrestricted 100% refund upon request. The request for a refund by the learner shall be honored in full without penalty or other consideration of any kind. The request for a refund may be made by the learner at any time without limitations before, during, or after course participation.

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Course Outline

Overview

Complex Regional Pain Syndrome (CRPS), previously known as reflex sympathetic dystrophy (RSD), reflex neurovascular dystrophy, Sudeck's atrophy, causalgia and algo-dystrophy/algo-neurodystrophy, is a broad term used to describe a chronic persistent pain that is disproportionate to any preceding injury and is not related anatomically to a specific peripheral nerve. (Salibi, et al, 2014)

Two types of CRPS have been described: CRPS I and CRPS II. For the most part, the clinical characteristics of both types are the same. The difference is based on the presence or absence of nerve damage: CRPS I (also known as reflex sympathetic dystrophy) is not associated with nerve damage, whereas CRPS II (also known as causalgia) is associated with objective evidence of nerve damage.

CRPS-I (RSD) is a syndrome that usually develops after an initiating noxious event, is not limited to the distribution of a single peripheral nerve, and appears to be disproportionate to the inciting event. It is associated at some point with evidence of edema, changes in skin, blood flow, abnormal sudomotor activity in the region of the pain, allodynia or hyperalgesia. The site is usually in the distal aspect of an affected extremity or with a distal to proximal gradient. The peripheral nervous system and possibly the central nervous system are involved.

CRPS-II (Causalgia) is the presence of burning pain, allodynia, and hyperpathia usually in the hand or foot after partial injury to a nerve or one of its major branches. Pain is within the distribution of the damaged nerve but not generally confined to a single nerve.

Historically, CRPS has been described in three phases throughout the development of the disease as time progresses. However, the disease does not necessarily proceed in these phases as some can be prolonged, shortened or even cease to exist. (Salibi, et al, 2014)

- The acute phase is characterized by the development of a diffuse severe pain unrelated to a specific dermatome or nerve and local edema occurring following a traumatic event or even without any clear etiology.

- This is followed by a dystrophic phase, which lasts between three and six months, and where marked edema, abnormal sweating, skin and soft tissue changes become more prominent.

- The final stage is characterized by the presence of atrophic changes. This could include: contractures, waxy and brittle looking skin, and ridged nails, in addition to evidence of demineralization on bone radiography which may lead to severe deep bone pain.

Epidemiology

CRPS is an uncommon disease with a prevalence of <2%. A higher incidence of CRPS is reported in patients between the ages of 40-49 and in women (76%). The upper extremity is affected twice as commonly as the lower limb, and a fracture is the most common trigger (46%). In 10-26% of patients with CRPS, no precipitating factors can be found.

Rates of the occurrence of CRPS range from 2% to 5% after carpal tunnel surgery, and 22% to 39% after distal radius fractures. A higher incidence of CRPS has been reported in highly comminuted, intra-articular distal radius fractures, fractures with associated ulnar styloid injuries, and in fractures treated with closed reduction and casting (versus percutaneous pinning). An elevated intra-cast pressure as a result of a tight cast or extreme positions was also a common risk factor for development of CRPS. (Sebastin, 2011)

Clinical Features

The most common symptom of CRPS is prolonged pain that may be constant and, in some people, extremely uncomfortable or severe. The pain may feel like a burning or "pins and needles" sensation, or as if someone is squeezing the affected limb. The pain may spread to include the entire arm or leg, even though the precipitating injury might have been only to a finger or toe. Pain can sometimes even travel to the opposite extremity. There is often increased sensitivity in the affected area, such that even light touch or contact is painful (allodynia).

People with CRPS also experience constant or intermittent changes in temperature, skin color, and swelling of the affected limb. This is due to abnormal microcirculation caused by damage to the nerves controlling blood flow and temperature. An affected arm or leg may feel warmer or cooler compared to the opposite limb. The skin on the affected limb may change color, becoming blotchy, blue, purple, pale, or red.

Other common features of CRPS include:
- Changes in skin texture on the affected area; it may appear shiny and thin
- Abnormal sweating pattern in the affected area or surrounding areas
- Changes in nail and hair growth patterns
- Stiffness in affected joints
- Problems coordinating muscle movement, with decreased ability to move the affected body part, and
- Abnormal movement in the affected limb, most often fixed abnormal posture (dystonia) but also tremors in or jerking of the affected limb.

Pain
The hallmark of CRPS is pain and mobility problems disproportionate to those expected from the initial injury. The initial and primary complaint occurring in one or more

extremities is described as severe, constant, burning and/or deep aching pain. All tactile stimulation of the skin (e.g. wearing clothing, a light breeze) may be perceived as painful. Repetitive tactile stimulation may cause increasing pain with each tap and when the repetitive stimulation stops, there is often a prolonged after-sensation of pain (hyperpathia). There may be diffuse tenderness or point-tender spots in the muscles of the affected region due to small muscle spasms called muscle trigger points (myofascial pain syndrome). There may be spontaneous sharp jabs of pain in the affected region that occur without provocation (paroxysmal dysesthesias).

Skin Changes
The skin over the affected area may present shiny, dry or scaly. Hair growth is frequently altered. Initially growing abnormally coarse and then thin. Nail growth rate and quality may also be disturbed on the affected extremity. Abnormal sympathetic vasomotor activity may be associated with skin that is either warm or cold to touch. The patient may perceive sensations of warmth or coolness in the affected limb without even touching it. Changes in skin color can range from a white mottled appearance to a red or blue appearance. Hyperhydrosis is not uncommon.

Swelling
Pitting or hard (brawny) edema is usually diffuse and localized to the painful and tender region.

Movement Disorder
Patients with CRPS have difficulty moving the affected limb secondary to pain and stiffness of muscles and joints. Decreased mobilization of extremities can lead to disuse atrophy. Some patients have little pain due to CRPS but instead they have a great deal of stiffness and difficulty initiating movement. Tremors, dystonic posturing and myoclonic jerks may also be present in patients with CRPS. Some patients describe a slow "drawing up of muscles" in the extremity due to increased muscle tone leaving the hand-fingers or foot-toes in a fixed position (dystonia).

Spreading Symptoms
Typically, CRPS symptoms are initially localized to the site of injury. With time, the symptoms tend to become more diffuse throughout the affected limb, and may spread to other regions of the body. Three distinct patterns of spreading CRPS symptoms have been described.
1. "Continuity type" - symptoms spread upward from the initial site, e.g. from the hand to the shoulder.
2. "Mirror-image type" - symptoms spread to the opposite limb.
3. "Independent type" - symptoms spread to a separate, distant region of the body.

Bone Changes
Patchy osteoporosis of the affected area is commonly noted as the condition progresses from sub-acute to chronic stages.

Comorbidities

Of the CRPS comorbidities, region-specific osteoporosis and muscle hypotrophy may also be considered as objective indicators of the disease, although there is a lack of published data on this topic. Osteoporosis is a systemic, skeletal disease characterized by low bone density and microarchitectural deterioration of bone tissue with a consequent increase in bone fragility. Osteoporotic fractures are the clinical endpoints of bone fragility and carry significant mortality and morbidity. Such musculoskeletal entities associated with CRPS are likely to develop in response to disuse due to immobilization and can cause further pain, fracture and disability. It has been reported that CRPS-associated bone loss is characterized by elevated bone turnover and bone resorption. Extensive type 1 and type 2 muscle fiber atrophy, as well as neurogenic myopathy, have also been reported in CRPS patients. (Hind & Johnson, 2014)

Etiology

It is unknown what causes some individuals to develop CRPS while others with similar trauma do not. In more than 90 percent of cases, the condition is triggered by a clear history of trauma or injury. The most common triggers are fractures, sprains/strains, soft tissue injury (such as burns, cuts, or bruises), limb immobilization (such as being in a cast), or surgical or medical procedures (such as needlestick). CRPS represents an abnormal response that magnifies the effects of the injury. Some people respond excessively to a trigger that causes no problem for other people.

Peripheral nerve abnormalities found in individuals with CRPS usually involve the small unmyelinated and thinly myelinated nerve fibers that carry pain messages and signals to blood vessels. Because small fibers in the nerves communicate with blood vessels, small nerve fiber injuries may trigger the many different symptoms of CRPS. Molecules secreted from the ends of hyperactive injured small nerve fibers are thought to contribute to inflammation and blood vessel abnormalities. These peripheral nerve abnormalities in turn trigger abnormal neurological function in the spinal cord and brain, leading in some cases to complex disorders of higher cortical function.

Another abnormality in CRPS involves the blood vessels in the affected limb, which may dilate or leak fluid into the surrounding tissue, causing red, swollen skin. The underlying muscles and deeper tissues can become starved of oxygen and nutrients, causing muscle and joint pain and damage. At times, the blood vessels may over-constrict, causing cold, white, or bluish skin. The dilation and constriction of small blood vessels is controlled by small nerve fiber axons as well as chemical messengers in the blood.

CRPS also affects the immune system. High levels of inflammatory chemicals (cytokines) have been found in the tissues of people with CRPS. These contribute to the redness, swelling, and warmth reported by many patients. CRPS is more common in individuals with other inflammatory and autoimmune conditions such as asthma.

Limited data suggest that CRPS also may be influenced by genetics. Rare family clusters of CRPS have been reported. Familial CRPS may be more severe with earlier onset, greater dystonia, and more than one limb being affected.

Occasionally CRPS develops without any known injury. There may have been an internal injury caused by an infection, a blood vessel problem, or entrapment of the nerves, so careful examination is needed to determine the cause and treat it.
In many cases, CRPS is the result of multiple causes that act together to produce various symptom.

Pathophysiology

Most patients (90%) with CRPS have an initiating noxious event (trauma/ischemia/nerve compression) in the clinical history. The reason why only some patients develop CRPS is unclear. There is also no single pathophysiological mechanism that can explain the diversity and the heterogeneity of the symptoms (edema, central nervous system symptoms, joint involvement, etc.). (Sebastin, 2011)

It is now accepted that multiple mechanism are involved and the presentation depends on the relative contribution of each mechanism. The pathophysiologic mechanisms that are believed to contribute to CRPS include alterations in cutaneous innervation (lower density of small fibers-C and Aα), central and peripheral sensitization (increased excitability of nociceptive neurons in the spinal cord and local tissues as a result of persistent noxious input from tissue damage/nerve injury mediated by neuropeptides), altered function of the sympathetic nervous system; lower levels of circulating catecholamines; increased levels of local and systemic inflammatory cytokines, lower systemic levels of anti-inflammatory cytokines, genetic factors, and psychological factors (anxiety, anger, and depression). The most prominent mechanism appears to be the inflammatory process because all the classic signs of inflammation (edema, redness, hyperthermia, and impaired function) are conspicuous in the early stages of CRPS. (Sebastin, 2011)

Risk Factors

There are several risks factors that have been identified for CRPS:
1. Prolonged immobilization (e.g. due to bone fractures or soft tissue injury, especially in upper or lower distal extremities)
2. Longer than normal healing times
3. Delays in reactivation after immobility (e.g. due to inadequate control of acute pain)
4. Lack of weight-bearing on lower extremities
5. Tobacco use which can delay fracture healing
6. Reluctance to move or reactivate due to fear of pain or injury (fear avoidance)
7. Nerve damage

Prevention

CRPS may be preventable if the alert clinician is on the lookout for CRPS. Therefore, in addition to the usual protocols for a particular injury, close surveillance of patients at risk for CRPS is recommended. For such patients, extra office visits may be appropriate, especially if the clinician suspects a patient may not follow the expected course of recovery within the expected length of time.

CRPS may be prevented or arrested by early identification of risk factors and taking prompt action when they are present. The emphasis should be on pain control, mobilization, and monitoring from onset of acute injury through the normally expected treatment time, typically a few weeks to a few months.

Following these few precautions can help prevent CRPS:
- A. Identify potential cases early and take action
    1. Intentionally solicit symptoms and watch for signs
    2. Educate the patient to immediately report any CRPS symptoms
    3. Give clear and specific instructions to patients about mobilization and use of the injured part
    4. Manage patients' expectations about pain relief
- B. Encourage active participation in rehabilitation
    1. Have patient keep a recovery diary, logging pain level, symptoms, and activities
    2. Provide or facilitate activity coaching
    3. Set recovery goals with specified time frames (e.g. next office or PT visit)
    4. Use medications or interventional procedures in concert with rehabilitative strategies

Prognosis

The outcome of CRPS varies from person to person. Almost all children and teenagers have good recovery. Occasionally individuals are left with unremitting pain and crippling, irreversible changes despite treatment. Anecdotal evidence suggests early treatment, particularly rehabilitation, is helpful in limiting the disorder, but this benefit has not yet been proven in clinical studies. More research is needed to understand the causes of CRPS, how it progresses, and the role of early treatment.

Diagnosis

Most patients with pain in an extremity do not have CRPS. Clinicians should avoid the mistake of labeling an individual with CRPS based solely on the presence of widespread extremity pain that does not fit an obvious anatomic pattern. In many instances, there is no diagnostic label that adequately describes the patient's symptoms. It is often more appropriate to describe the condition as "regional pain of

undetermined origin" than to diagnose CRPS. However, it is equally important to identify CRPS when it does occur, so that appropriate treatment can be instituted.

Diagnostic Criteria

CRPS is a clinical diagnosis based on patient symptoms and signs elicited on physical examination. The International Association for the Study of Pain (IASP) recently published a newly revised criteria for diagnosing CRPS diagnostic criteria. (Harden, 2013)

IASP- proposed revised CRPS clinical diagnostic criteria (Harden, 2013)

A clinical diagnosis of CRPS can be made when the following criteria are met:
Patient must meet the criteria below.
(1) Continuing pain, which is disproportionate to any inciting event
(2)   At least one symptom in *three of the four* following categories:
- *Sensory:* reports of hyperesthesia and/or allodynia.
- *Vasomotor:* reports of temperature asymmetry and/or skin color changes and/or skin color asymmetry.
- *Sudomotor/edema:* reports of edema and/or sweating changes and/or sweating asymmetry.
- *Motor/trophic:* reports of decreased range of motion and/or motor dysfunction (weakness, tremor, dystonia) and/or trophic changes (hair, nail, skin).
(3)   At least one sign at time of evaluation in *two or more* of the following categories:
- *Sensory:* evidence of hyperalgesia (to pinprick) and/or allodynia (to light touch and/or deep somatic pressure and/or joint movement).
- *Vasomotor:* evidence of temperature asymmetry and/or skin color changes and/or asymmetry. Temperature asymmetry should ideally be established by infrared thermometer measurements showing at least a 1 degree Celsius difference between the affected and unaffected extremities.
- *Sudomotor/edema:* evidence of edema and/or sweating changes and/or sweating asymmetry. Upper extremity volumetrics may be performed by therapists that have been trained in the technique to assess edema.
- *Motor/trophic:* evidence of decreased range of motion and/or motor dysfunction (weakness, tremor, dystonia) and/or trophic changes (hair, nail, skin).
(4) No other diagnosis that better explains the signs and symptoms

The IASP retained the division of CRPS into types I and II subtypes depending on the absence or presence of evidence of peripheral nerve injury, respectively. In addition, a third diagnostic subtype called CRPS-NOS was recommended. This is because approximately 15% of the patients previously diagnosed with CRPS (based on IASP criteria) would not fully meet the new clinical diagnostic criteria. Patients who have fewer than three symptom or two sign categories, or who were not showing a sign at the time of the examination, but had exhibited this previously, and whose signs and symptoms were felt to be best explained by CRPS would receive a diagnosis of CRPS-NOS. (Sebastin, 2011)

Diagnosis of complex regional pain syndrome continues to be controversial. Some believe that the clinical criteria used by the IASP is overly sensitive and unable to differentiate well between those patients with other pain complaints and those with actual complex regional pain syndrome (CRPS).

Sudomotor/sweating limb differences and atrophic changes, including nail, hair and skin changes, occur in less than half of the clinical CRPS patients; in contrast, verified temperature asymmetry, edema, and decreased motor function are frequently cited as predictive.

Historically some authors have used 2°C as a limit for temperature differences and others have used lower cutoffs. It is unlikely a patient has CRPS if they do not have resting temperature asymmetry; however, resting temperature asymmetry differences may be due to a variety of reasons other than CRPS.

Causing an objectively measured, sympathetically evoked response is likely to be more predictive of CRPS than merely resting temperature differences or resting sudomotor/sweating differences. Temperature testing at any one point in time is probably not sensitive and able to distinguish between patients with pain complaints and those with CRPS.

Evaluation

Before the diagnosis of CRPS is established, an experienced practitioner must perform a detailed neurological and musculoskeletal exam to exclude other potentially treatable pain generators or neurological lesions. The medical records should reasonably document the following:

History

Medical History
A thorough patient history is an important part of the evaluation of pain. In taking such a history, factors influencing a patients' current status can be made clear and taken into account when planning diagnostic evaluation and treatment. History should ascertain the following elements:
- Work History/Occupation – impact on ability to perform job duties, work history, job description, and mechanical requirements of the job.
- Current employment status.
- Family Environment
- Activities of Daily Living – usual daily vocational, social, and recreational activities.
- Past and present psychological health
- Sleep disturbances.
- Causality - How did this injury occur?
- Presenting symptoms related to CRPS:

- Pain
- Swelling
- Changes in skin color.
- Asymmetry in nail and/or hair growth.
- Abnormal sweat patterns of the involved extremity.
- Motor dysfunction- limited active range-of-motion, atrophy, tremors, dystonia, and weakness.
- Subjective temperature changes of the affected area.

Pain History
Characterization of the patient's pain and of the patient's response to pain is one of the key elements in treatment.
- Site of Pain – localization and distribution of the pain help determine the type of pain the patient has (i.e., central versus peripheral).
- Pain Diagram drawing to document the distribution of pain**.**
- Visual Analog Scale (VAS) including a discussion of the range of pain during the day and how activities, use of modalities, and other actions affect the intensity of pain
- Duration.
- Circumstances during which the pain began (e.g. an accident, an illness, a stressful incident or spontaneous onset).
- Pain characteristics – such as burning, shooting, stabbing, aching). Time of pain occurrence as well as intensity, quality and radiation give clues to the diagnosis and potential treatment. Quality of pain can be helpful in identifying neuropathic pain which is normally present most of the day, at night and is described as burning**.**
- Response of pain to activity. List of activities which aggravate or exacerbate, ameliorate, or have no effect on the level of pain.
- Associated Symptoms – Does the patient have numbness or paresthesia, dysesthesia, weakness, bowel or bladder dysfunction, decreased temperature, increased sweating, cyanosis or edema? Is there local tenderness, allodynia, hyperesthesia or hyperalgesia?

Medical Management History
History of diagnostic tests and results including but not limited to any response to sympathetic nerve blocks, results of general laboratory studies, EMG and nerve conduction studies, radiological examinations, including triple phase bone scan or thermography with autonomic stress testing, and tests of sudomotor functioning.
- Prior Treatment - Chronological review of medical records including previous medical evaluations and response to treatment interventions.   In other words, what has been tried and what has been helpful?
- Prior Surgery – If the patient has had prior surgery specifically for the pain, he/she may be less likely to have a positive outcome.
- History of and current use of medications, including over-the-counter and herbal/dietary supplements to determine drug usage (or abuse) interactions and efficacy of treatment.

- Psychosocial Functioning – Due to the high incidence of co-morbid problems in populations that develop chronic pain, it is recommended that patients diagnosed with CRPS be referred for a full psychosocial evaluation. All patients with CRPS have chronic pain and are likely to suffer psychosocial consequences.
- Pre-existing Conditions – Treatment of these conditions is appropriate when the preexisting condition affects recovery from chronic pain.
- Family history pertaining to similar disorders

Substance Use/Abuse:
- Alcohol use.
- Smoking history and use of nicotine replacements.
- History of current and prior prescription and/or illicit drug use and abuse.
- The use of caffeine or caffeine-containing beverages.
- Substance abuse information may be only fully obtainable from multiple sources over time. Patient self reports may be unreliable. Patient self reports should always be checked against medical records.

Other Factors Affecting Treatment Outcome:
- Compensation/Disability/Litigation.
- Treatment Expectations – What does the patient expect from treatment: complete relief of pain or reduction to a more tolerable level?

Physical Examination

Inspection - Changes in appearance of the involved area, to include trophic changes, changes in hair and nail growth, muscular atrophy, changes in skin turgor, swelling and color changes.

Temperature Evaluation - Palpable temperature changes may not be detectable in early disease stages, and the examiner will generally only be able to appreciate significant temperature variations. Objective testing is preferred to demonstrate temperature asymmetries. Temperature differences of 1˚C may be significant; however, these differences also occur commonly with other pain conditions.

Edema - is an important finding in CRPS. Its presence should be described in detail by the clinician and when possible verified with objective testing such as volumetric testing or bilateral circumference measurements, usually performed by therapists.

Motor Evaluation – Involuntary movements, dystonia, muscle weakness, atrophy, or limited range of active motion in the involved limb(s).

Sensory Evaluation – A detailed sensory examination is crucial in evaluating a patient with chronic pain complaints, including the presence of allodynia and the anatomic pattern of any associated sensory abnormalities to light touch, deep touch, pain and thermal stimulation. Quantitative sensory testing may be useful.

Musculoskeletal Evaluation – Presence of associated myofascial problems, such as contractures, ROM or trigger points.

Evaluation of Nonphysiologic Findings – Determine the presence of the following: variabilities on formal exam including variable sensory exam; inconsistent tenderness, and/or swelling secondary to extrinsic sources. Inconsistencies between formal exam and observed abilities of range of motion, motor strength, gait and cognitive/emotional state; and/or observation of inconsistencies between pain behaviors, affect and verbal pain rating, and physical re-examination can provide useful information.

Diagnostic Imaging

Plain Film Radiography
A radiological finding in CRPS may be unilateral osteoporosis; however, osteoporosis may be absent in many cases. In CRPS-I, the osteoporosis may be rapid in progression. The disorder typically affects the distal part of an extremity such as phalanges, hand or foot; however intermediate joints such as the knee or elbow may be involved. Contralateral x-rays should be taken for comparison and should include the distal phalanges.

The radiological appearance of osteoporosis has been characterized as spotty or patchy. Although CRPS-I may exist in the absence of osteoporosis, the diagnosis of CRPS-I cannot be made solely on the basis of radiographic appearance or the osteoporosis alone.

Triple Phase Bone Scan
Radionucleotide imaging scintigraphy employing radio-pharmaceutical technetium coupled to a phosphate complex has been used to help facilitate the diagnosis of CRPS-1. Clinical information can be derived from each of the three phases of the bone scan following injection. In the early course of CRPS-I, there is an increased uptake seen during Phase 1. However, in the late course of the disease process, there can actually be a decreased uptake seen. In Phase 2, which reflects the soft tissue vascularity, an increased diffuse uptake may be appreciated during the early course of CRPS-I. During Phase 3, one will see a diffuse uptake of multiple bone involvement of the involved limb, reflecting the bone turnover secondary to osteoporosis. Negative bone scans may be found in up to 40 percent of patients clinically diagnosed with CRPS-I; however, when positive it may help to confirm the diagnosis of CRPS-I.

Diagnostic Injections

Diagnostic sympathetic injections are generally accepted procedures to aid in the diagnosis of CRPS I & II. Sympathetic blocks lack specificity for CRPS I & II. Each diagnostic injection has inherent risk and risk versus benefit should always be evaluated when considering injection therapy. Since these procedures are invasive, less invasive or non-invasive procedures should be considered first. Selection of patients, choice of procedure, and localization of the level for injection should be determined by clinical

information. Injections with local anesthetics of differing duration are required to confirm a diagnosis. In some cases, injections at multiple levels may be required to accurately diagnose pain.

Since fluoroscopic and/or CT guidance during procedures is recommended to document technique and needle placement, an experienced physician should perform the procedure.

Complications may include transient neurapraxia, nerve injury, inadvertent spinal injection, infection, venous or arterial vertebral puncture, laryngeal paralysis, respiratory arrest, vasovagal effects, as well as permanent neurological damage.

To confirm the accuracy of the block there should be a documented temperature difference between the affected and unaffected extremities of at least 1 degree Celsius. The interpretation of the test result is primarily based upon pain relief of 50 percent or greater and evidence of functional improvement, for at least the duration of the local anesthetic used. The diagnostic significance of the test result should be evaluated in conjunction with clinical information and further information should be obtained from functional and physical reassessment performed by physical and/or occupational therapy the same day of the block.

Stellate Ganglion Block
For diagnosis and treatment of sympathetic pain involving the face, head, neck, and upper extremities secondary to CRPS-I and II. This block is commonly used for differential diagnosis and is one of the treatments for CRPS-I pain involving the upper extremity. For diagnostic testing, two blocks are given over a 3-14 day period. For a positive response, pain relief should be 50% or greater for the duration of the local anesthetic and pain relief should be associated with demonstrated functional improvement.

Lumbar Sympathetic Block
Useful for diagnosis and treatment of pain of the pelvis and lower extremity secondary to CRPS-I and II. This block is commonly used for differential diagnosis and is the preferred treatment of sympathetic pain involving the lower extremity. For diagnostic testing, two blocks are given over a 3-14 day period. For a positive response, pain relief should be 50% or greater for the duration of the local anesthetic and pain relief should be associated with demonstrated functional improvement.

Thermographic Assessment

There is good evidence that CRPS is characterized by inhibition of sympathetic cutaneous responses on the affected side and by blunted sympathetic response to physiologic stimuli. Based on the relatively common finding of temperature discrepancy in non-CRPS patients with chronic pain, a stress test thermogram should be used. Infrared thermography may be useful for patients with suspected CRPS-I and II. Thermography can distinguish abnormal thermal asymmetry of 1.0 degree Celsius

which is not distinguishable upon physical examination. It may also be useful in cases of suspected small caliber fiber neuropathy and to evaluate patient response to sympatholytic interventions.

Functional Autonomic Stress Testing
Functional autonomic stress testing may include the following methods:
1. Cold Water Stress Test (Cold Pressor Test): Paroxysmal response in the affected upper extremity is strongly suggestive of vasomotor instability.
2. Warm Water Stress Test: Paroxysmal response in the affected upper extremity is strongly suggestive of vasomotor instability.
3. Whole Body Thermal Stress: Analysis of persistent non-dermal temperature anomalies in response to whole body thermal stress.

Autonomic Test Battery
These tests measure asymmetries in physiologic manifestations of autonomic activity between an affected limb and an unaffected contralateral limb. Skin temperature reflects vasomotor activity and sweat output measures sudomotor activity. The results of the three test components must be combined and scored. Resting skin temperature (RST), resting sweat output (RSO), and quantitative sudomotor axon reflex test (QSART) are a generally accepted test battery. There is good evidence that CRPS is characterized by inhibition of sympathetic cutaneous responses on the affected side and by blunted sympathetic response to physiologic stimuli. The tests can provide additional information regarding malfunction of the sympathetic system and the diagnosis of CRPS. As with all diagnostic testing, the results must be interpreted in relationship to the patient's signs and symptoms.

> **Infrared Resting Skin Temperature (RST):** Provides thermographic measurements between the affected and unaffected limb. Generally, a 1° Celsius difference is significant. Given the previous discussion regarding differences in resting temperature between the affected and unaffected limbs in non-CRPS patients, the temperature findings may need to be interpreted cautiously as they do not reflect a stress on the sympathetic system.

> **Resting Sweat Output (RSO):** Measures an increase or reduction of 50 percent between the affected and unaffected limb.

> **Quantitative Sudomotor Axon Reflex Test (QSART):** Measures the sweat output elicited by iontophoretic application of acetylcholine. An increase or reduction of 50 percent between the affected and unaffected limb is significant. The results of these tests should be recorded separately as abnormal or within the normal range. A further assessment can then be done by the clinician when this information is collaborated with clinical findings. However clinical analysis is separate from the strict interpretation of each of the above three tests.

Psychosocial Evaluation

Psychosocial evaluations are generally accepted, well-established, and widely used diagnostic procedures not only with selected use in acute pain problems, but also with more widespread use in subacute, chronic pain and CRPS populations. Diagnostic evaluations should distinguish between conditions that are pre-existing, aggravated by the current injury or work related.

Psychosocial evaluations should determine if further psychosocial or behavioral interventions are indicated for patients diagnosed with CRPS. The interpretations of the evaluation should provide clinicians with a better understanding of the patient in his or her social environment, thus allowing for more effective rehabilitation.

While there is some agreement about which psychological factors need to be assessed in patients with CRPS, a comprehensive psychological evaluation should attempt to identify both primary psychiatric risk factors or "red flags" (e.g. psychosis, active suicidality), as well as secondary risk factors or "yellow flags" (e.g. moderate depression, job dissatisfaction). Significant personality disorders must be taken into account when considering a patient for spinal cord stimulation and other major procedures.

All patients who are diagnosed as having CRPS should be referred for a psychosocial evaluation, as well as concomitant interdisciplinary rehabilitation treatment. This referral should be performed in a way so as to not imply that the patient's claims are invalid, or that the patient is malingering or mentally ill. Even in cases where no diagnosable mental condition is present, these evaluations can identify social, cultural, coping and other variables that may be influencing the patient's recovery process and may be amenable to various treatments including behavioral therapy. As pain is understood to be a biopsychosocial phenomenon, these evaluations should be regarded as an integral part of the assessment of CRPS.

Physical and Functional Evaluation

Generally well-accepted tests that are performed as part of a skilled assessment of the patients' capacity to perform functional tasks, his/her strength capacities, and/or physical work demand classifications and tolerance.

Computer-Enhanced Evaluations: may include isotonic, isometric, isokinetic and/or isoinertial measurement of movement, range-of-motion, endurance or strength.   Values obtained can include degrees of motion, torque forces, pressures, or resistance. Indications include determining validity of effort, effectiveness of treatment and demonstrated motivation. These evaluations should not be used alone to determine return to work restrictions.

Functional Capacity Evaluations (FCE): is a comprehensive or modified evaluation of the various aspects of function as they relate to the worker's ability to return-to-work.

Areas such as endurance, lifting (dynamic and static), postural tolerance, specific range-of-motion, coordination and strength, worker habits, employability and financial status, as well as psychosocial aspects of competitive employment may be evaluated. Components of this evaluation may include: (a) musculoskeletal screen; (b) cardiovascular profile/aerobic capacity; (c) coordination; (d) lift/carrying analysis; (e) job-specific activity tolerance; (f) maximum voluntary effort; (g) pain assessment/psychological screening; (h) non-material and material handling activities.

Standardized national guidelines (such as National Institute for Occupational Safety and Health (NIOSH) should be used as the basis for FCE recommendations. When a FCE is being used to determine return to a specific jobsite, the provider is responsible for fully understanding the job duties. A jobsite evaluation is frequently necessary. FCEs cannot be used in isolation to determine work restrictions. FCEs should not be used as the sole criteria to diagnose malingering. Full FCEs are rarely necessary. In many cases, a work tolerance screening will identify the ability to perform the necessary job tasks.

Jobsite Evaluation and Alterations: is a comprehensive analysis of the physical, mental, and sensory components of a specific job. The goal of the jobsite evaluation is to identify any job modification needed to ensure the safety of the employee upon return to work. These components may include, but are not limited to: (a) postural tolerance (static and dynamic); (b) aerobic requirements; (c) range-of-motion; (d) torque/force; (e) lifting/carrying; (f) cognitive demands; (g) social interactions; (h) visual perceptual; (i) environmental requirements of a job; (j) repetitiveness; and (k) essential functions of a job; and (l) ergonomic set up. Job descriptions provided by the employer are helpful but should not be used as a substitute for direct observation.

Jobsite evaluation and alteration should include input from a health care professional with experience in ergonomics or a certified ergonomist; the employee, and the employer. The individual must be observed performing all job functions in order for the jobsite evaluation to be a valid representation of a typical workday.

A jobsite evaluation may include observation and instruction of how work is done, what material changes (desk, chair) should be made, and determination of readiness to return to work. Requests for a jobsite evaluation should describe the expected goals for the evaluation. Goals may include, but are not limited to the following:
- To determine if there are potential contributing factors to the person's condition and/or for the physician to assess causality;
- To make recommendations for, and to assess the potential for ergonomic changes;
- To provide a detailed description of the physical and cognitive job requirements;
- To assist the patient in their return to work by educating them on how they may be able to do their job more safely in a bio-mechanically appropriate manner;
- To give detailed work/activity restrictions.

Vocational Assessment: Once an authorized practitioner has reasonably determined and objectively documented that a patient will not be able to return to his/her former employment and can reasonably prognosticate final restrictions, implementation of a timely vocational assessment can be performed. The vocational assessment should provide valuable guidance in the determination of future rehabilitation program goals. It should clarify rehabilitation goals, which optimize both patient motivation and utilization of rehabilitation resources. If prognosis for return to former occupation is determined to be poor, except in the most extenuating circumstances, vocational assessment should be implemented within 3 to 12 months post-injury.

Work Tolerance Screening (Fitness for Duty): is a determination of an individual's tolerance for performing a specific job based on a job activity or task. It may include a test or procedure to specifically identify and quantify work-relevant cardiovascular, physical fitness and postural tolerance. It may also address ergonomic issues affecting the patient's return-to-work potential. May be used when a full FCE is not indicated.

Treatment Phases

Treatment can be thought of in phases. Although each phase has a general time frame, the time needed for an individual case is difficult to predict. Each phase can be shortened or lengthened as needed, allowing patients to move from one phase to another depending on their individual progress.

Phase One – Prevention and Mitigation of CRPS Risk Factors
The duration of Phase One will depend on the expected healing time for the specific injury, commonly spanning the first few weeks following the injury. The emphasis during Phase One is on pain control, appropriate mobilization, and monitoring of pain and function. After an initial injury, the patient should be encouraged to move as much as is safe for whatever injury he or she has. PT/OT will be directed by what is appropriate for the specific injury and may be limited during this phase.

While there are no fixed rules as to the time of immobilization for a given injury, 6-8 weeks for the upper extremity and 8-12 weeks for the lower extremity are typical durations. It may be worth noting that mobility can continue in spite of casting. For example, a patient in a long arm cast can still move his fingers, and a patient in an ankle cast can still move his toes. With appropriate immobilization, pain should generally decrease progressively with time. If pain is not decreasing over time, the clinician must reassess the plan of treatment. If at any point the patient demonstrates unusual distress, pain complaints that appear to be out of proportion to the injury, or unexpectedly slow progress, the frequency of clinic visits should be increased. In this situation, it is important to consider the possibility of a missed diagnosis or an unrecognized comorbidity such as a behavioral or substance abuse disorder.

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Phase Two – Recovery is Not Normal
The sooner treatment for suspected CRPS is initiated, the more likely it is that the long term outcome will be good. When recovery is delayed, and if no specific cause for the delay is identified, CRPS may be the diagnosis. Referral to a pain management or rehabilitation medicine specialist is strongly recommended.

Phase Three – CRPS Initial Treatment
Following a CRPS diagnosis, treatment should be initiated early and aggressively. Care should be coordinated and include physical or occupational therapy, psychological or psychiatric therapy, and medication management. An initial sympathetic block trial may be considered in cases that do not demonstrate functional gains during initial treatment.

Phase Four – CRPS Intensive Treatment
When the patient is unlikely to benefit from Phase Three treatment, an immediate referral to a multidisciplinary treatment program may be made. If the patient's condition has not substantially improved within 6 weeks of Phase Three treatment, referral to an approved multidisciplinary treatment program is recommended.

Interdisciplinary Programs

The historical ambiguity and poor understanding of the pathophysiology of CRPS makes it one of the most challenging syndromes to treat successfully. As a result of this, and despite a substantial increase in knowledge over the past decade, there are still many unanswered questions regarding the best treatment modality. Because CRPS exhibits a wide spectrum of presentations stemming from both etiology and affected body part, its treatment cannot be based on a single treatment modality. Published literature and clinical trials to date have failed to provide strong evidence for a single definitive treatment for CRPS. Instead, it requires a multidisciplinary approach that involves a wide range of services including pain specialists, physical and occupational therapists and psychologists. (Salibi, et al, 2014)

Interdisciplinary programs are the gold standard of treatment for individuals with chronic pain who have not responded to less intensive modes of treatment. There is good evidence that interdisciplinary programs which include screening for psychological issues, identification of fear-avoidance beliefs and treatment barriers, and establishment of individual functional and work goals, will improve function and decrease disability. These programs should assess the impact of pain and suffering on the patient's medical, physical, psychological, social, and/or vocational functioning. In general, interdisciplinary programs evaluate and treat multiple and sometimes irreversible conditions, including but not limited to painful musculoskeletal, neurological, and other chronic painful disorders and psychological issues, drug dependence, abuse or addiction, high levels of stress and anxiety, failed surgery; and pre-existing or latent psychopathology. The number of professions involved in the team in a chronic pain program may vary due to the complexity of the needs of the person served. It is recommended that referral to an interdisciplinary program occur within 6 months post-

injury in patients with delayed recovery unless successful surgical interventions or other medical and/or psychological treatments complications intervene

Individuals with chronic pain need to be treated as outpatients within a continuum of treatment intensity. Outpatient chronic pain programs are available with services provided by a coordinated interdisciplinary team within the same facility (formal) or as coordinated among practices by the authorized treating physician (informal). Formal programs are able to provide coordinated, high intensity level of services and are recommended for most chronic pain patients who have received multiple therapies during acute management.

Patients with addiction problems or high dose opioid or other drugs of abuse use may require inpatient and/or outpatient chemical dependency treatment programs before or in conjunction with other interdisciplinary rehabilitation.

Informal interdisciplinary pain programs may be considered for patients who are currently employed, those who cannot attend all day programs, those with language barriers, or those living in areas not offering formal programs. Before treatment has been initiated, the patient, physician, and insurer should agree on treatment approach, methods, and goals. Generally, the type of outpatient program needed will depend on the degree of impact the pain has had on the patient's medical, physical, psychological, social and/or vocational functioning.

Inpatient pain rehabilitation programs are rarely needed but may be necessary for patients with any of the following conditions:
      (a) High risk for medical instability;
      (b) Moderate-to-severe impairment of physical/functional status;
      (c) Moderate-to-severe pain behaviors;
      (d) Moderate impairment of cognitive and/or emotional status;
      (e) Dependence on medications from which he or she needs to be withdrawn;
      (f) The need for 24-hour supervised nursing.

Whether formal or informal programs, they should be comprised of the following dimensions:

Communication:
To ensure positive functional outcomes, communication between the patient, payor and all professionals involved must be coordinated and consistent. Any exchange of information must be provided to all professionals, including the patient. Care decisions should be communicated to all and should include the family or other support system.

Documentation:
Through documentation by all professionals involved and/or discussions with the patient, it should be clear that functional goals are being actively pursued and measured on a regular basis to determine their achievement or need for modification.

Treatment Modalities:
Use of modalities may be necessary early in the process to facilitate compliance with and tolerance to therapeutic exercise, physical conditioning, and increasing functional activities. Active treatments should be emphasized over passive treatments. Active treatments should encourage self-coping skills and management of pain, which can be continued independently at home or at work. Treatments that can foster a sense of dependency by the patient on the caregiver should be avoided. Treatment length should be decided based upon observed functional improvement. All treatment timeframes may be extended based upon the patient's positive functional improvement.

Therapeutic Exercise Programs:
A therapeutic exercise program should be initiated at the start of any treatment rehabilitation. Such programs should emphasize education, independence, and the importance of an on-going exercise regime. There is good evidence that exercise alone or part of a multi-disciplinary program results in decreased disability for workers with non-acute low back pain. There is no sufficient evidence to support the recommendation of any particular exercise regimen over any other exercise regimen.

Return-to-Work:
The treating clinician should continually evaluate the patient for their potential to return to work. When return-to-work is an option, it may be appropriate to implement a Work Hardening Program. For patients currently employed, efforts should be aimed at keeping them employed. Formal rehabilitation programs should provide assistance in creating work profiles.

Patient Education:
Patients with pain need to re-establish a healthy balance in lifestyle. All providers should educate patients on how to overcome barriers to resuming daily activity, including pain management, decreased energy levels, financial constraints, decreased physical ability, and change in family dynamics.

Psychosocial Evaluation and Treatment:
Psychosocial evaluation should be initiated, if not previously done. Providers of care should have a thorough understanding of the patient's personality profile; especially if dependency issues are involved. Psychosocial treatment may enhance the patient's ability to participate in pain treatment rehabilitation, manage stress, and increase their problem-solving and self-management skills.

Vocational Assistance:
Vocational assistance can define future employment opportunities or assist patients in obtaining future employment.

Interdisciplinary programs are characterized by a variety of disciplines that participate in the assessment, planning, and/or implementation of the treatment program. These programs are for patients with greater levels of perceived disability, dysfunction, de-conditioning and psychological involvement. Programs should have sufficient personnel

to work with the individual in the following areas: behavior, functional, medical, cognitive, pain management, psychological, social and vocational.

Formal Interdisciplinary Pain Rehabilitation

A formal Interdisciplinary Pain Rehabilitation Program provides outcomes-focused, coordinated, goal-oriented interdisciplinary team services to measure and improve the functioning of persons with pain and encourage their appropriate use of health care system and services. The program can benefit persons who have limitations that interfere with their physical, psychological, social, and/or vocational functioning. The program shares information about the scope of the services and the outcomes achieved with patients, authorized providers, and insurers.

The interdisciplinary team maintains consistent integration and communication to ensure that all interdisciplinary team members are aware of the plan of care for the patient, are exchanging information, and implement the plan of care. The team members make interdisciplinary team decisions with the patient and then ensure that decisions are communicated to the entire care team.

The Medical Director of the pain program should ideally be board certified in pain management, or be board certified in his or her specialty area and have completed a one-year fellowship in interdisciplinary pain medicine or palliative care recognized by a national board, or have two years of experience in an interdisciplinary pain rehabilitation program. Individuals who assist in the accomplishment of functional, physical, psychological, social and vocational goal must include: a medical director, pain team physician(s), and pain team psychologist. Other disciplines on the team may include, but are not limited to: Biofeedback Therapist, Occupational Therapist, Physical Therapist, Registered Nurse, case manager, exercise physiologist, psychologist, psychiatrist, and/or nutritionist.

Occupational Rehabilitation is an interdisciplinary program addressing a patient's employability and return-to-work. It includes a progressive increase in the number of hours per day that a patient completes work simulation tasks until the patient can tolerate a full workday. A full workday is case specific and is defined by the previous employment of the patient. Safe work place practices and education of the employer and social support system regarding the person's status should be included. This is accomplished by addressing the medical, psychological, behavioral, physical, functional, and vocational components of employability and return-to-work.
There is some evidence that an integrated care program, consisting of workplace interventions and graded activity teaching that pain need not limit activity, is effective in returning patients with chronic low back pain to work, even with minimal reported reduction of pain.

Informal Interdisciplinary Rehabilitation Program

A coordinated interdisciplinary pain rehabilitation program is one in which the treating physician coordinates all aspects of care. This type of program is similar to the formal programs in that it is goal oriented and provides interdisciplinary rehabilitation services to manage the needs of the patient in the following areas: functional, medical, physical, psychological, social, and vocational.

This program is different from a formal program in that it involves lower frequency and intensity of services/treatment. Informal rehabilitation is geared toward those patients who do not need the intensity of service offered in a formal program or who cannot attend an all-day program due to employment, daycare, language or other barriers. Patients should be referred to professionals experienced in outpatient treatment of chronic pain. Communication among care providers regarding clear objective goals and progress toward the goals is essential. Employers should be involved in return to work and work restrictions and the family/social support system should be included in the treatment plan. Other disciplines likely to be involved include biofeedback therapist, occupational therapist, physical therapist, registered nurse, psychologist, case manager, exercise physiologist, psychiatrist, and/or nutritionist.

Physical and Occupational Therapy

Physical and occupational therapy are important components of the management of CRPS primarily by desensitizing the effected body part, restoring motion, and improving function. Physical/occupational therapy interventions for CRPS can include specific modalities such as transcutaneous electrical nerve stimulation, progressive weight bearing, tactile desensitization, massage, and contrast bath therapy. These interventions tailored specifically to each individual person can be used to improve pain and function to help people return to normal activities of daily living. Some people at certain stages of the disease are incapable of participating in physical therapy due to touch intolerance.

People with CRPS often develop guarding behaviors where they avoid using or touching the affected limb. This inactivity exacerbates the disease and perpetuates the pain cycle. Therefore, optimizing the multimodal treatment is paramount to allow for use of the involved body part. Physical/occupational therapy works best for most patients, especially goal-directed therapy, where the patient begins from an initial point, regardless of how minimal, and then endeavors to increase activity each week. Therapy is directed at facilitating the patient to engage in rehabilitative activities, movement and stimulation of the affected areas.

Therapy Plan

A physical or occupational therapy treatment plan specific to CRPS should be developed by a therapist who is experienced in the treatment of CRPS. Therapy should

be active, focused on desensitization, normalizing movement patterns, improving strength and range of motion and improving functional activities. A CRPS- focused physical or occupational therapy plan should include the following elements:

A. Evaluation to include:
    1. Date of onset of original injury (helpful in determining if early or late stage) and a date of onset of the CRPS symptoms and signs
    2. Baseline objective measurements including ROM of all involved joints, strength, sensory loss, hypersensitivity, appearance, temperature, function (e.g. weight bearing and gait for lower extremity; fine motor tasks, pinch and grip for upper extremity), and use of assistive devices, braces and orthotics. If possible, include objective measurements of swelling
B. Specific, measurable functional goals which will allow assessment of progress and the effectiveness of treatment for the affected area
C. All treatment programs should include a core of:
    1. Desensitization
    2. Neuromuscular re-education, which might include graded motor imagery, mirror box therapy or other techniques to promote normalization of neuromuscular function
    3. A progressive, active exercise program designed to promote improvement in ROM, strength and endurance
    4. Activities targeted to attain the functional goals, e.g. weight bearing and gait training for the lower extremity and fine motor tasks for the upper extremity
    5. A monitored home exercise program to promote the patient's participation in rehabilitation activities on a daily basis
D. Documentation should be done at least every two weeks to include:
1. Reassessment of relevant baseline measurements. This provides objective evidence of response or non-response to treatment
2. Assessment of progress toward functional goals (e.g. how the condition interferes with daily activities or activities related to employment)
3. Level of patient motivation
4. Participation in a home exercise program

Before initiation of any therapeutic procedure, the therapist must consider these important issues in the care of the injured individual:

A. Patients undergoing therapeutic procedure(s) should be released or returned to modified or restricted work duty during their rehabilitation at the earliest appropriate time.
B. Reassessment of the patient's status in terms of functional improvement should be documented after each treatment. If patients are not responding within the recommended time periods, alternative treatment interventions, further diagnostic studies or consultations should be pursued. Continued treatment should be monitored using objective measures such as:
    • Return to work or maintaining work status.
    • Performing activities of daily living (ADL).
    • Decrease in usage of medications, and

- Measurable functional gains, such as increased range-of-motion or documented increase in strength.
C. Clinicians should provide and document education to the patient. No treatment plan is complete without addressing issues of individual and/or group patient education as a means of facilitating self-management of symptoms.
D. Psychological or psychosocial screening should be performed on all chronic pain patients.

Active Therapies

Active therapy is based on the philosophy that therapeutic exercise and/or activity are beneficial for restoring flexibility, strength, endurance, function, range-of-motion, and can alleviate discomfort. It requires an internal effort by the individual to complete a specific exercise or task. This form of therapy requires supervision and verbal, visual and/or tactile instruction(s) from a therapist. All active therapy plans should be made directly with patients in the interest of achieving long-term individualized goals.

The goal of active therapy is to teach the patient exercises that they can perform regularly on their own. Active therapy should promote independence and self-reliance in managing the physical pain as well as to improve the functional status. Patients should be instructed to continue active therapies at home as an extension of the treatment process in order to maintain improvement levels. Follow-up visits to reinforce and monitor progress and proper technique are recommended. Home exercise can include exercise with or without mechanical assistance or resistance and functional activities with assistive devices.

Aquatic Therapy

The water provides a buoyancy force that lessens the amount of force of gravity applies to the body, and the pool should be large enough to allow full extremity range-of-motion and full erect posture. The decreased gravity effect allows the patient to have a mechanical advantage increases the likelihood of successful therapeutic exercise. Multiple limb involvement, weight bearing problems, and vasomotor abnormalities are frequently treated with water exercise. Indications for individuals who may not tolerate active land-based or full-weight-bearing therapeutic procedures, or who require augmentation or other therapy. The therapy may be indicated for individuals who:

- Cannot tolerate active land-based or full-weight bearing therapeutic procedures.
- Require increased support in the presence of proprioceptive deficit.
- Are at risk of compression fracture due to decreased bone density.
- Have symptoms that are exacerbated in a dry environment.

The pool should be large enough to allow full extremity range of motion and fully erect posture; and be heated to 88 to 92 degrees. Aquatic vests, belts and other devices can be used to provide stability, balance, buoyancy, and resistance. A self-directed program is recommended after the supervised aquatics program has been established, or, alternatively a transition to a self-directed dry environment exercise program.

Functional Activities
Well-established interventions which involve the use of therapeutic activity to enhance mobility, body mechanics, employability, coordination, and sensory motor integration.

Gait Training
Indications include the need to promote normal gait pattern with assistive devices and/or to reduce risk of fall or loss of balance. This may include instruction in safety and proper use of assistive devices and gait instruction on uneven surfaces and steps (with or without railings).

Neuromuscular Re-education
Skilled application of exercise with manual, mechanical, or electrical facilitation to enhance strength, movement patterns, neuromuscular response, proprioception, kinesthetic sense, coordination, education of movement, balance, and posture. Indications include the need to promote neuromuscular responses through carefully timed proprioceptive stimuli, to elicit and improve motor activity in patterns similar to normal neurologically developed sequences, and improve neuromotor response with independent control.

Stress Loading
Considered a reflex and sensory integration technique involving the application of a compressive load and a carry load. It is carried out in a consistent, progressive manner and integrated as part of a home program. Use of this technique may increase symptoms initially, but symptoms generally subside with program consistency. This technique is used for upper as well as lower extremities

Therapeutic Exercise
With or without mechanical assistance or resistance, may include isoinertial, isotonic, isometric and isokinetic types of exercises. Indications include the need for cardiovascular fitness, reduced edema, improved muscle strength; improved connective tissue strength and integrity, increased bone density, promotion of circulation to enhance soft tissue healing, improvement of muscle recruitment, improved proprioception, and coordination, and increased range of motion are used to promote normal movement patterns. Can also include alternative/complementary exercise movement therapy.

Therapeutic exercise programs should be tissue specific to the injury and address general functional deficits as identified in the diagnosis and clinical assessment. Patients should be instructed in and receive a home exercise program that is progressed as their functional status improves. Upon discharge, the patient would be independent in the performance of the home exercise program and would have been educated in the importance of continuing such a program. Educational goals would be to maintain or further improve function and to minimize the risk for aggravation of symptoms in the future.

Mirror Visual Feedback (MVF)
The mirror box, which is a small box with a mirror on one side, is a novel affordable device which may benefit the recovery of sensorimotor impairments associated with CRPS. The effected hand is hidden inside the box and the non-effected hand moves outside the box. By watching the reflection of the non-effected hand in the mirror, the desired movements of the effected hand can be observed.

MVF was first described and implemented in the treatment of phantom limb pain in 1996. However, it was not until 2003 that it was used in CRPS patients. Several hypotheses have been proposed in the literature outlining the underlying mechanisms of pain reduction during mirror therapy. (Salibi, et al, 2014)

In order to compensate for this dissociation, a mirror is used to superimpose the non-affected extremity in order to create a visual illusion of a pain free movement of the affected one. This theory was supported by an analogy with the mismatch between vestibular and visual information associated with nausea. Similarly, in CRPS patients, there is no identifiable nociceptive etiology, therefore leading to a mismatch between the motor intention, proprioceptive and visual feedback. It is hypothesized that the absence of a normal sensory feedback can change the cortical recognition and produce reorganized body representation that is proportional to severity of pain. Therefore, providing an alternative sensory feedback in the form of a visual illusion by using a mirror will eventually decrease pain. (Salibi, et al, 2014)

Graded Motor Imagery (GMI)
The combination of mirror therapy and motor imagery is called graded motor imagery (GMI). GMI is a comprehensive program aimed at improving cortical organization and activation of motor networks. Traditionally, GMI consists of three phases: limb laterality recognition task, an imagined limb movement task (motor imagery) and finally mirror therapy. The patient in the first step has to determine whether the pictured hand is left or right. This concept of laterality training depends on an intact body schema, activates premotor cortices and re-establishes left and right orientation within the brain. In the next step, the patient will be asked to imagine a limb posture imitating what is shown in a picture without moving the affected hand. This will subsequently promote and activate both the premotor and primary motor cortices. The last step will involve using the aforementioned mirror therapy. (Salibi, et al, 2014)

Pain Exposure Physical Therapy (PEPT)
Pain exposure physical therapy (PEPT) is based on the premise that pain may be exacerbated and maintained by psychosocial and behavioral factors and, therefore, these factors must be addressed as a component of CRPS management.

PEPT is a functional form of physical therapy and consists of a progressive-loading exercise program and management of pain-avoidance behavior without the use of specific medication or analgesics. It is based on the assumption that behavioral and psychological factors can exacerbate pain and dysfunction and might help maintain the condition. Patients denominate clear treatment goals in the domains of activities and

participation. PEPT aims to decrease kinesiophobia, pain behavior and learned non-use, and increase self-confidence in the patient's own physical possibilities. Living without adaptations or living independently from caregivers, returning to work and employment, and restarting domestic life, self-care, mobility, hobbies and sports in a short time are the main treatment goals. Pain relief itself is not a primary treatment goal, and patients are informed that an increase in pain during or after the exercises and activities might occur. Patients are reassured that an increase in pain is not a sign of injury or tissue damage. In this respect, all conscious and unconscious signs of catastrophizing and kinesiophobic behavior are specified and talked through with the patient and partner. If, despite explanation, doubt remains about the treatment content or when patients are not motivated to act upon instructions of the therapists, the treatment should be ceased. (Barnhoorn, 2012)

The treatment consists of progressive-loading exercises and desensitization beyond the patients' pain limits. To decrease the enhanced skin sensitivity for touch and pressure, desensitization is carried out using self-massage and forced use of the affected arm or leg in daily activities. The progressive-loading exercises are tailored and focused on specific body functions using standard techniques in regular physical therapy, including passive and active exercises to mobilize joints and muscle stretching. During progressive loading, the therapists act mainly as instructors, rewarding functional progression and providing schedules for exercises and activities at home. Complaining about pain is discouraged and it should not be a reason to reduce the treatment intensity. (Barnhoorn, 2012)

Work Conditioning
These programs are work-related, outcome-focused, individualized treatment programs. Objectives of the program includes, but are not limited to, improvement of cardiopulmonary and neuromusculoskeletal functions (strength, endurance, movement, flexibility, stability, and motor control functions), patient education, and symptom relief. The goal is for patients to gain full or optimal function and return to work. The service may include the time-limited use of modalities, both active and passive, in conjunction with therapeutic exercise, functional activities, general conditioning body mechanics, and lifting techniques re-training. The patient should be assisted in learning to pace activities to avoid exacerbations.

These programs are usually initiated once re-conditioning has been completed but may be offered at any time throughout the recovery phase. It should be initiated when imminent return of a patient to modified- or full-duty is not an option, but the prognosis for returning the patient to work at completion of the program is at least fair to good.

Work Simulation
A program where an individual completes specific work-related tasks for a particular job and return to work. Use of this program is appropriate when modified duty can only be partially accommodated in the work place, when modified duty in the work place is unavailable, or when the patient requires more structured supervision. The need for

work place simulation should be based upon the results of a functional capacity evaluation and/or jobsite analysis.

Passive Therapies

Passive therapy includes those treatment modalities that do not require energy expenditure on the part of the patient. They are principally effective during the early phases of treatment and are directed at controlling symptoms such as pain, inflammation and swelling and to improve the rate of healing soft tissue injuries. They should be used adjunctively with active therapies such as postural stabilization and exercise programs to help control swelling, pain, and inflammation during the active rehabilitation process. Passive therapies may be used intermittently as a therapist deems appropriate or regularly if there are specific goals with objectively measured functional improvements during treatment. Or if there are episodes of acute pain superimposed upon a chronic pain problem.

The following passive therapies are listed in alphabetical order:

Fluidotherapy
Used primarily for desensitization and to facilitate increased active range of motion. Thermal heat conduction and convection is advantageous for vasodilation, muscle relaxation, and preparation for stress and activity (exercise).

Paraffin Bath
Indications include the need to enhance collagen extensibility before stretching, reduce muscle guarding, and to prepare for functional restoration activities.

Desensitization
Desensitization is accomplished through sensory integration techniques. Concurrent desensitization techniques are generally accepted as a treatment for CRPS. Home techniques using soft cloths of various textures, massage, and vibrators may be beneficial in reducing allodynia and similar sensory abnormalities.

Superficial Heat Therapy
Superficial heat is a thermal agent applied to raise the body tissue temperature. It is indicated before exercise to elevate the pain threshold, alleviate muscle spasm, and promote increased movement. Heat packs can be used at home as an extension of therapy in the clinic setting.

Home Program

Most patients have the ability to participate in a home program after completion of a supervised rehabilitation program. Programs should incorporate an exercise prescription including the continuation of an age-adjusted and diagnosis-specific program for aerobic conditioning, flexibility, stabilization, and strength. Some patients may benefit from the purchase or rental of equipment to maintain a home exercise

program. Determination for the need of home equipment should be based on medical necessity to maintain MMI, compliance with an independent exercise program, and reasonable cost. Before the purchase or long-term rental of equipment, the patient should be able to demonstrate the proper use and effectiveness of the equipment. Effectiveness of equipment should be evaluated on its ability to improve or maintain functional areas related to activities of daily living or work activity.

Some patients may have higher compliance with an independent exercise program at a health club versus participation in a home program. All exercise programs completed through a health club facility should focus on the same parameters of an age-adjusted and diagnosis-specific program for aerobic conditioning, flexibility, stabilization, and strength.

Durable Medical Equipment

Some patients may require ongoing use of self-directed modalities for the purpose of maintaining function and/or analgesic effect. Purchase or rental of modality based equipment should be done only if the assessment by the therapist has determined the effectiveness, compliance, and improved or maintained function by its application. It is generally felt that large expense purchases such as spas, whirlpools, and special mattresses are not necessary to maintain function.

Pharmacological Management

Pain inhibits movement, and inadequate pain control may be an obstacle to activity, so judicious use of medications for pain control can be a useful adjunct to therapy. There is no drug with high-quality evidence to support use in either pain reduction or facilitation of function in CRPS. However, various medications are commonly used in clinical practice to manage pain or associated symptoms in CRPS. The categories of medications often used include non-steroidal anti-inflammatory drugs (NSAIDs), anticonvulsants, antidepressants, opioids, N-methyl-D-aspartate receptor antagonists (NMDA), antihypertensives, alpha-adrenergic agents, calcitonin and bisphosphonates. Selection of a particular agent may be influenced by the specific symptom or associated co-morbidities. These medications may be useful in helping a patient engage in therapy and regain function — the keys to successful management of CRPS.

There is no single formula for pharmacological treatment of patients with chronic nonmalignant pain. A thorough medication history, including use of alternative and over the counter medications, should be performed at the time of the initial visit and updated periodically. It is incumbent upon the healthcare provider to thoroughly understand pharmacological principles when dealing with the different drug families, their respective side effects, Drug interactions, bioavailability profiles, and primary reason for each medication's usage. Patients should be aware that medications alone are unlikely to provide complete pain relief. In addition to pain relief, a primary goal of drug treatment is to improve the patient's function as measured behaviorally. In addition to taking

medications, continuing participation in exercise programs and using self–management techniques, such as biofeedback, cognitive behavioral therapy, and other individualized physical, and psychological practices are essential elements for successful chronic pain management.

Control of chronic non-malignant pain is expected to involve the use of medication. Strategies for pharmacological control of pain cannot be precisely specified in advance. Rather, drug treatment requires close monitoring of the patient's response to therapy, flexibility on the part of the prescriber and a willingness to change treatment when circumstances change. Many of the drugs utilized are licensed for indications other than analgesia, but are effective in the control of some types of chronic pain.

It is generally wise to begin management with lower cost medications whose efficacy equals higher cost medications and with a greater safety profile. Decisions to progress to more expensive, non-generic, and/or riskier products are made based on the drug profile, patient feedback, and improvement in function. The provider must carefully balance the untoward side effects of the different drugs with therapeutic benefits, as well as monitoring for any drug interactions.

Consensus regarding the use of opioids has generally been reached in the field of cancer pain, where nociceptive mechanisms are usually identifiable, expected survival may be short, and symptomatic relief is emphasized more than functional outcomes. In injured individuals, by contrast, central and neuropathic mechanisms frequently overshadow nociceptive processes, expected survival is relatively long, and return to a high level of function is a major goal of treatment. Approaches to pain, which were developed in the context of malignant pain, therefore may not be transferable to chronic non-malignant pain.

All medications should be given an appropriate trial in order to test for therapeutic effect. The length of an appropriate trial varies widely depending on the individual drug. Certain medications may take several months to determine the efficacy, while others require only a few doses. It is recommended that patients with CRPS be maintained on drugs that have the least serious side effects. For example, patients need to be tried or continued on acetaminophen and/or low-dose generic antidepressant medications whenever feasible as part of their overall treatment for chronic pain. Patients with renal or hepatic disease may need increased dosing intervals with chronic acetaminophen use. Chronic use of NSAIDs is generally not recommended due to increased risk of cardiovascular events and GI bleeding. There is good evidence that naproxen has the least risk for cardiovascular events when compared to other NSAIDs.

Opioid analgesics and other drugs of potential abuse such as sedative hypnotics or benzodiazepines may be used in properly selected cases for CRPS patients, with total elimination desirable whenever clinically feasible. It is strongly recommended that such pharmacological management be monitored or managed by an experienced pain medicine physician. Multimodal therapy is the preferred mode of treatment for chronic pain patients whether or not these drugs were used acutely or sub-acutely.

For CRPS management, a burst of oral steroids is usually prescribed initially followed by tricyclics. Bisphosphonates are used when osteotrophic changes are present. Neuropathic pain can be treated with a variety of medications; however, all have specific side effects and other interactions that clinicians must be mindful of. It is suggested that patients with significant peripheral neuropathic pain be trialed with a tricyclic medication initially, as low dose medication in this category frequently is tolerated and performs sufficiently to decrease pain 30 to 50%. When these fail, side effects are not tolerated, or a patient has medical issues precluding the use of this class of drugs, other appropriate medications can be tried. Second line drugs include the anti-convulsants gabapentin and pregabalin. There is little clinical outcome difference between the medications, although gabapentin may be better tolerated. Third line drugs are the SNRI's, which have demonstrated some effectiveness for treating neuropathic pain, and topical lidocaine. The SNRI duloxetine has not been shown to be superior to the tricyclic amitriptyline and there is no reason to prefer duloxetine in patients who have not been treated with a tricyclic**.**   Fourth line drugs are opioids and tramadol.

The following drug classes are listed in alphabetical order, not in order of suggested use which has been outlined above for neuropathic pain.

Oral Steroids - Inflammation is thought to be one of the first physiological changes in CRPS; therefore, strong anti-inflammatories should provide some relief especially if provided early. There is some evidence to support oral steroid use early in the course of CRPS. Early treatment may be trialed on patients who meet the clinical diagnostic criteria for CRPS and do not have contraindications to steroid use. Side effects in some patients include mood changes, fluid retention, hyperglycemia, gastric irritation and ulcers, aseptic necrosis, and others.

Bisphosphonates - are potent inhibitors of bone resorption.   There is good evidence that their use effectively decreases pain and some evidence it increases joint motion in patients with CRPS. It should not be used in those with severe renal dysfunction. Osteonecrosis of the jaw has been reported and there may be an association with atypical subtrochanter femoral fractures especially with long term use. The recommended dose and time period for treatment are not clear. There are no studies addressing use for patients without evidence of resorption and therefore it is not recommended for these patients.

Alpha-Acting Agents - Noradrenergic pain-modulating systems are present in the central nervous system and the alpha-2 adrenergic receptor may be involved in the functioning of these pathways. Alpha-2 agonists may act by stimulating receptors in the substantia gelatinosa of the dorsal horn of the spinal cord, inhibiting the transmission of nociceptive signals. Spasticity may be reduced by pre-synaptic inhibition of motor neurons. Given limited experience with their use, they cannot be considered first-line or second line analgesics for neurogenic or CRPS pain, but a trial of their use may be warranted in some cases of refractory pain.

Anticonvulsants - Although the mechanism of action of anticonvulsant drugs in neuropathic pain states remains to be fully defined, some appear to act as nonselective sodium channel blocking agents. A large variety of sodium channels are present in nervous tissue, and some of these are important mediators of nociception, as they are found primarily in unmyelinated fibers and their density increases following nerve injury. While the pharmacodynamic effects of the various anticonvulsant drugs are similar, the pharmacokinetic effects differ significantly. Gabapentin and pre-gabapentin, by contrast, are relatively non-significant enzyme inducers, creating fewer drug interactions. Because anticonvulsant drugs may have more problematic side-effect profiles, their use should usually be deferred until tricyclic-related medications have failed to relieve pain. All patients on these medications should be monitored for suicidal ideation. There is an association between older anticonvulsants including gabapentin and non-traumatic fractures for patients older than 50; this should be taken into account when prescribing these medications.

Antidepressants - Are classified into a number of categories based on their chemical structure and their effects on neurotransmitter systems. Their effects on depression are attributed to their actions on disposition of norepinephrine and serotonin at the level of the synapse; although these synaptic actions are immediate, the symptomatic response in depression is delayed by several weeks. When used for chronic pain, the effects may in part arise from treatment of underlying depression, but may also involve additional neuromodulatory effects on endogenous opioid systems, raising pain thresholds at the level of the spinal cord.

Pain responses may occur at lower drug doses with shorter times to symptomatic response than are observed when the same compounds are used in the treatment of mood disorders. Neuropathic pain, diabetic neuropathy, post-herpetic neuralgia, and cancer-related pain may respond to antidepressant doses low enough to avoid adverse effects that often complicate the treatment of depression. First line drugs for neuropathic pain are the tricyclics with the newer formulations having better side effect profiles. SNRIs are considered second line drugs due to their costs and the number needed to treat for a response. SSRIs are used generally for depression rather than neuropathic pain and should not be combined with moderate to high-dose tricyclics. All patients being considered for anti-depressant therapy should be evaluated and continually monitored for suicidal ideation and mood swings.

Hypnotics and Sedatives - Sedative and hypnotic drugs decrease activity and induce drowsiness and moderate agitation in some individuals. Many other medications, such as antihistamines and antidepressants also produce these side effects. Due to the addiction potential, withdrawal symptoms, and sedating side effects benzodiazepines and other similar drugs found in this class, are not generally recommended. They should be used with extreme caution when the patient is on chronic opioids management. When used, extensive patient education should be documented. Some of these medications have long half-lives; sleep apnea can occur or be aggravated on these medications. Many unintentional drug deaths are related to concomitant opioid

and benzodiazepine drug use. Retrograde amnesia can occur and is implicated in "sleep driving," "sleep eating" and other activities.

Nonsteroidal Anti-Inflammatory Drugs (NSAIDs) - Nonsteroidal Anti-Inflammatory Drugs (NSAIDs) are useful for pain and inflammation. In mild cases, they may be the only drugs required for analgesia. There are several classes of NSAIDs and the response of the individual injured worker to a specific medication is unpredictable. For this reason, a range of NSAIDs may be tried in each case with the most effective preparation being continued. Patients should be closely monitored for adverse reactions. The US Food and Drug Administration advise all NSAIDs may cause an increased risk of serious cardiovascular thrombotic events, myocardial infarction, and stroke, which can be fatal. There is good evidence that naproxen has a more favorable cardiovascular risk profile than other NSAIDs when used over a long period for chronic pain. NSAIDs are associated with abnormal renal function, including renal failure, as well as, abnormal liver function. Certain NSAIDs may have interactions with various other medications. Individuals may have adverse events not listed above. Intervals for metabolic screening are dependent upon the patient's age, general health status and should be within parameters listed for each specific medication. Complete blood count (CBC), liver and renal function should be monitored at least every six months in patients on chronic NSAIDs and initially when indicated.

Opioids - are the most powerful analgesics. Their use in acute pain and moderate-to-severe cancer pain is well accepted. Their use in chronic nonmalignant pain, however, is fraught with controversy and lack of scientific research.

Opioids include some of the oldest and most effective drugs used in the control of severe pain. Most of their analgesic effects have been attributed to their modification of activity in pain pathways within the central nervous system; however, it has become evident that they also are active in the peripheral nervous system. Activation of receptors on the peripheral terminals of primary afferent nerves can mediate anti-nociceptive effects, including inhibition of neuronal excitability and release of inflammatory peptides. Some of their common side effects are drowsiness, constipation, nausea and possible testosterone decrease with longer term use.

The central nervous system actions of these drugs account for much of their analgesic effect and for many of their other actions, such as respiratory depression, drowsiness, mental clouding, reward effects, and habit formation. With respect to the latter, it is crucial to distinguish between three distinct phenomena: tolerance, dependence, and addiction.

- Tolerance refers to a state of adaptation in which exposure to a drug over time causes higher doses of that drug to be required in order to produce the same physiologic effect and/or markedly diminished effect with continued use of the same amount that drug.

- Dependence refers to a set of disturbances in body homeostasis that leads to withdrawal symptoms, which can be produced with abrupt discontinuation, rapid reduction, decreasing blood levels, and/or by administration of an antagonist.
- Addiction is a primary, chronic, neurobiological disease, with genetic, psychological, and environmental factors influencing its development and manifestations. It is a behavioral pattern of drug craving and seeking which leads to a preoccupation with drug procurement and an aberrant pattern of use. The drug use is frequently associated with negative consequences.

Opioids are generally not recommended for controlling pain associated with CRPS. Tricyclics, SNRIs, and anticonvulsants should be tried before considering opioids for neuropathic pain.

In most cases, analgesic treatment should begin with acetaminophen, aspirin, and NSAIDs. While maximum efficacy is modest, they may reduce pain sufficiently to permit adequate function. When these drugs do not satisfactorily reduce pain, medications specific to the diagnosis should be used.

Skeletal Muscle Relaxants - are most useful for acute musculoskeletal injury or exacerbation of injury. Chronic use of benzodiazepines or any muscle relaxant is not recommended due to their habit-forming potential, seizure risk following abrupt withdrawal, and documented contribution to deaths of patients on chronic opioids due to respiratory depression.

Topical Medications - Topical medications, such as lidocaine and capsaicin, may be an alternative treatment for neuropathic disorders and is an acceptable form of treatment in selected patients.

- Capsaicin – Capsaicin offers a safe and effective alternative to systemic NSAID therapy. Although it is quite safe, effective use of capsaicin is limited by the local stinging or burning sensation that typically dissipates with regular use, usually after the first 7 to 10 days of treatment. Patients should be advised to apply the cream on the affected area with a plastic glove or cotton applicator and to avoid inadvertent contact with eyes and mucous membranes.

- Lidocaine – Evidence is mixed for long-term use of lidocaine topically. There is some evidence that a 5% lidocaine patch may be used as a secondary option for patients with focal neuropathic pain. A 30 to 50% pain reduction may be achieved in those who tolerate the patch. Up to three patches may be used simultaneously for twelve hours per day. It should only be applied to intact skin. Metered dose 8% pump sprays have also been used and usually require a three times per day reapplication. There is some evidence that the 8% sprays are effective for short-term, 2 week use. However, the effects of long-term use are unknown.

- Topical Salicylates and Nonsalicylates – have been shown to be effective in relieving pain in acute musculoskeletal conditions and single joint osteoarthritis. Topical salicylate and nonsalicylates achieve tissue levels that are potentially therapeutic, at least with regard to COX inhibition. Other than local skin reactions, the side effects of therapy are minimal, although not non-existent and the usual contraindications to use of these compounds needs to be considered. Local skin reactions are rare and systemic effects were even less common. Their use in patients receiving warfarin therapy may result in alterations in bleeding time. Overall, the low level of systemic absorption can be advantageous; allowing the topical use of these medications when systemic administration is relatively contraindicated such as is the case in patients with hypertension, cardiac failure, or renal insufficiency.

Invasive Therapies

Invasive interventions began to expand over the past decade in a relatively progressive manner as the current research has revealed new facets of CRPS etiology. It has been recommended that these should be applied in appropriately timed manner, and depending on need, they may serve as an adjunctive role for pain relief in order to facilitate reanimation of the affected extremity in addition to complementing the functional goals of the rehabilitation process. Numerous therapies have been proposed. These included nerve blocks, drug infusions and implantable pain treatment devices. (Salibi et al, 2014)

Surgical Interventions

Surgical procedures are seldom meant to be curative and should be employed in conjunction with other treatment modalities for maximum functional benefit.

Prior to surgical intervention, the patient and clinical staff members should identify functional operative goals and the likelihood of achieving improved ability to perform activities of daily living or work activities and the patient should agree to comply with the pre- and post-operative treatment plan including home exercise. The clinician should be especially careful to make sure the patient understands the amount of post-operative therapy required and the length of partial- and full-disability expected post-operatively.

Neurostimulation
This involves electrical stimulation of neural tissues by surgical implantation of electrodes into specific areas of the brain or spinal cord. As an invasive treatment option with potential significant complications, it is considered an end-stage treatment. (Salibi et al, 2014)

Spinal Cord Stimulation - Spinal cord stimulation (SCS) is the delivery of low-voltage electrical stimulation to the spinal cord or peripheral nerves to inhibit or block the sensation of pain. The system uses implanted electrical leads and a battery powered

implanted pulse generator. Some evidence shows that SCS is superior to re-operation and conventional medical management for severely disabled patients who have failed conventional treatment and have Complex Regional Pain Syndrome (CRPS I).

Currently, spinal cord stimulation devices have been FDA approved as an aid to in the management of chronic intractable pain of the trunk and/or limbs.

While there is no evidence demonstrating effectiveness for use of SCS with for CRPS II, it is generally accepted that SCS can be used for patients who have this condition. SCS may be most effective in patients with CRPS I or II who have not achieved relief with oral medications, rehabilitation therapy, or therapeutic nerve blocks, and in whom the pain has persisted for longer than 6 months

Serious, less common complications of SCS include spinal cord compression, paraplegia, epidural hematoma, epidural hemorrhage, undesirable change in stimulation, seroma, CSF leakage, infection, erosion, and allergic response. Other complications consist of dural puncture, hardware malfunction or equipment migration, pain at implantation site, loss of pain relief, chest wall stimulation, and other surgical risks. The most frequent complications are reported to be electrode migration and loss of paresthesia.

Spinal cord stimulation is indicated for individuals with established CRPS I or II with persistent functionally limiting pain who have failed conservative therapy including active and/or passive therapy, pre-stimulator trial psychiatric evaluation and treatment, medication management, and therapeutic injections. Habituation to opioid analgesics in the absence of a history of addictive behavior does not preclude the use of SCS. Patients with severe psychiatric disorders, and issues of secondary gain are not candidates for the procedure. Approximately, one third to one half of patients who qualify for SCS can expect a substantial reduction in pain relief; however, it may not influence allodynia, and hypesthesia. Patients' expectations need to be realistic, and therefore, patients should understand that the SCS intervention is not a cure for their pain but rather a masking of their symptomatology which might regress over time. There appears to be a likely benefit of up to 3 years. Patients must meet the following criteria in order to be considered for neurostimulation:

- Confirmed CRPS I or II who have significant functional limitations from neuropathic pain involving the hand or foot after greater than 6 months of conventional management
- A comprehensive psychiatric or psychological evaluation prior to the stimulator trial has been performed.
- All reasonable surgical and non-surgical treatment has been exhausted; and
- The topography of pain and its underlying pathophysiology are amenable to stimulation coverage (the entire painful extremity area has been covered); and
- A successful neurostimulation screening test of at least 3 to 7 days.

For a spinal cord neurostimulation screening test, a temporary lead is implanted at the level of pain and attached to an external source to validate therapy effectiveness. A screening test is considered successful if the patient meets both of the following criteria: (a) experiences a 50% decrease in CRPS pain, which may be confirmed by visual analogue scale (VAS) or Numerical Rating Scale (NRS), and (b) demonstrates objective functional gains or decreased utilization of pain medications. Objective, measurable, functional gains should be evaluated by the therapist and physician prior to and before discontinuation of the trial.

The procedure may be performed either as an open or a percutaneous procedure, depending on the presence of epidural fibrosis and the anatomical placement required for optimal efficacy. During the final procedure the patient must be awakened to establish full coverage from the placement of the lead.   One of the most common failures is misplaced leads. Functional improvement is anticipated for up to 3 years or longer when objective functional improvement has been observed during the time of neurostimulation screening exam.

Following the surgery, active and/or passive therapy should be employed to improve function. Implantable stimulators will require frequent monitoring such as adjustment of the unit and replacement of batteries. Estimated battery life of SCS implantable devices is usually 5 – 10 years depending on the manufacturer.

Peripheral Nerve Stimulation
There are no randomized controlled studies for this treatment. This modality should only be employed with a clear nerve injury or when the majority of pain is clearly in a nerve distribution in patients who have completed 6 months of other appropriate therapy including pre-trial psychosocial evaluation and treatment. A screening trial should take place over 3 to 7 days and is considered successful if the patient meets both of the following criteria: (a) experiences a 50% decrease in pain, which may be confirmed by Visual Analogue Scale (VAS) or Numerical Rating Scale (NRS) and (b) demonstrates objective functional gains or decreased utilization of pain medications. Objective, measurable, functional gains should be evaluated by the therapist prior to and before discontinuation of the trial. It may be used for proven occipital, ulnar, median and other isolated nerve injuries.

Surgical Sympathectomy - Surgical sympathectomy was previously considered a popular option for treatment of a wide array of hyperactive sympathetic syndromes such as CRPS. However, the procedure has recently been associated with a high rate of post-sympathectomy neuralgia. Because of this, surgical sympathectomy is no longer recommended. (Salibi et al, 2014)

Sympathetic Nerve Blocks (SNBs)

Sympathetic nerve blocks involve blocking the sympathetic nervous system by injecting local anesthetic agents directly into the sympathetic neural structures such as the stellate ganglion block (SGB) (for upper extremity) or the lumbar sympathetic block

(LSB) (for lower extremity).

Moderate evidence is available to support the efficacy of classic Stellate Ganglia Blocks and Lumbar Sympathetic Blocks. With the lack of defining criteria of a successful block, their analgesic effects may be enhanced when applied in conjunction with other treatment modalities. (Salibi et al, 2014)

Sympathetic blocks have long been a standard treatment for CRPS and can be useful for a subset of cases. Stellate ganglion blocks (cervical sympathetic blocks) and lumbar sympathetic blocks are widely used in the management of upper and lower extremity CRPS. An initial trial of up to three sympathetic blocks should be considered when the condition fails to improve with conservative treatment, including analgesia and physical therapy.

The most common way to administer sympathetic blocks is single local anesthetic injections. Selection of sympathetic block technique depends on each case, reflecting in part the patient's needs and the interventional pain specialist's preference and expertise. The current standard of practice is to use image guided approaches, such as with fluoroscopy and ultrasound, since complications of blind injections may include airway hematomas, inadvertent intravascular or central neuraxial injections, and esophageal puncture.

When sympathetic blocks are helpful, the benefit is evident within the first days following the nerve block. The optimal timing, number, or frequency of blocks, have not been specified. Patients who have a shorter duration of symptoms seem to have a greater response to treatment. Documentation of a physiologic response (e.g., change in skin temperature of the affected limb or Horner's syndrome) is required to demonstrate that the block was successful. For sympathetic blocks to support lasting improvement, they should be combined with physical and behavioral therapies. Therapy should occur within 24 hours of the block or, if possible, on the same day of the block. An effective block is expected to produce at least 50% improvement in pain and a concomitant increase in function. Sympathetic blocks may be repeated only when there is objective evidence of progressive improvement in pain and function.

Indications – Greater than 50% pain relief and demonstrated functional improvement from previous diagnostic or therapeutic blocks. Range of motion or increased strength are examples of objective gains that can be documented for most CRPS patients.

Complications – Complications may include transient neurapraxia, nerve injury, inadvertent spinal injection, infection, venous or arterial vertebral puncture, laryngeal paralysis, respiratory arrest, vasovagal effects, as well as permanent neurologic damage.

Treatment Parameters – To be effective as a treatment modality, the patient should be making measurable progress in their rehabilitation program and should be achieving an

increasing or sustained duration of relief between blocks. If appropriate outcomes are not achieved, changes in treatment should be undertaken.

Other Therapeutic Interventions

Psychological Services

It is not uncommon for a fear-avoidance behavior pattern to emerge with a CRPS diagnosis. Patients are frequently fearful that pain indicates danger. They are sometimes concerned that ongoing pain means their condition has been misdiagnosed. Consequently, education and frequent reassurance are essential. This may be addressed using cognitive-behavioral therapy. In many cases, there is a more substantial psychological barrier to using the limb that warrants direct attention. If a co-morbid mental illness is identified that warrants formal psychiatric evaluation and treatment, screening or referral to the appropriate specialist may be needed.

Acupuncture

Acupuncture is the insertion and removal of filiform needles to stimulate acupoints (acupuncture points). It can only be performed by practitioners with the appropriate credentials in accordance with state and other applicable regulations. It is often recommended for chronic pain patients who are trying to increase function and/or decrease medication usage and have an expressed interest in this modality. Western medicine studies suggest that acupuncture stimulates the nervous system at the level of the brain, promotes deep relaxation, and affects the release of neurotransmitters. Acupuncture is commonly used as an alternative or in addition to traditional Western pharmaceuticals. It may be used when pain medication is reduced or not tolerated; as an adjunct to physical rehabilitation, surgical intervention; and/or as part of multidisciplinary treatment to hasten the return of functional activity.

Acupuncture with electrical stimulation is the use of electrical current (micro- amperage or milli-amperage) on the needles at the acupuncture site. It is used to increase effectiveness of the needles by continuous stimulation of the acupoint. Physiological effects (depending on location and settings) can include endorphin release for pain relief, reduction of inflammation, increased blood circulation, analgesia through interruption of pain stimulus, and muscle relaxation.

Biofeedback

Biofeedback is a form of behavioral medicine that helps patients learn self-awareness and self-regulation skills for the purpose of gaining greater control of their physiology, such as muscle activity, brain waves, and measures of autonomic nervous system activity. There is good evidence that biofeedback and cognitive behavioral therapy are equally effective in managing chronic pain. Stress-related psycho-physiological reactions may arise as a reaction to organic pain and in some cases may cause pain.

Electronic instrumentation is used to monitor the targeted physiology and then displayed or fed back to the patient visually, auditorily, or tactilely with coaching by a biofeedback specialist.

Indications for biofeedback include individuals who are suffering from musculoskeletal injury where muscle dysfunction or other physiological indicators of excessive or prolonged stress response affects and/or delays recovery. Other applications include training to improve self-management of pain, anxiety, panic, anger or emotional distress, opioid withdrawal, insomnia/sleep disturbance, and other central and autonomic nervous system imbalances. Biofeedback is often utilized for relaxation training. Mental health professionals may also utilize it as a component of psychotherapy, where biofeedback and other behavioral techniques are integrated with psychotherapeutic interventions. Biofeedback is often used in conjunction with physical therapy or medical treatment.

Recognized types of biofeedback include the following:

- **EMG/Electromyogram (EMG):** Used for self-management of pain and stress reactions involving muscle tension.

- **Skin Temperature:** Used for self-management of pain and stress reactions, especially vascular headaches.

- **Respiration Feedback (RFB):** Used for self-management of pain and stress reactions via breathing control.

- **Respiratory Sinus Arrhythmia (RSA):** Used for self-management of pain and stress reactions via synchronous control of heart rate and respiration. Respiratory sinus arrhythmia is a benign phenomenon which consists of a small rise in heart rate during inhalation, and a corresponding decrease during exhalation. This phenomenon has been observed in meditators and athletes, and is thought to be a psycho-physiological indicator of health.

- **Heart Rate Variability (HRV):** Used for self-management of stress via managing cardiac reactivity.

- **Electrodermal Response (EDR):** Used for self-management of stress involving palmar sweating or galvanic skin response.

- **Electroencephalograph (EEG, QEEG):** Used for self-management of various psychological states by controlling brainwaves.

The goal in biofeedback treatment is normalizing the physiology to the pre-injury status to the extent possible and involves transfer of learned skills to the workplace and daily life. Candidates for biofeedback therapy or training should be motivated to learn and practice biofeedback and self-regulation techniques. In the course of biofeedback treatment, patient stressors are discussed and self-management strategies are devised. If the patient has not been previously evaluated, a psychological evaluation should be performed prior to beginning biofeedback treatment for chronic pain. The psychological evaluation may reveal cognitive difficulties, belief system conflicts, somatic delusions,

secondary gain issues, hypochondriasis, and possible biases in patient self-reports, which can affect biofeedback. Home practice of skills is often helpful for mastery and may be facilitated by the use of home training tapes.

Psychologists or psychiatrists, who provide psycho-physiological therapy which integrates biofeedback with psychotherapy, should be either Biofeedback Certification International Alliance (BCIA) certified or practicing within the scope of their training. All non-licensed health care providers of biofeedback for chronic pain patients must be BCIA certified and shall have their biofeedback treatment plan approved by the authorized treating psychologist or psychiatrist. Biofeedback treatment must be done in conjunction with the patient's psychosocial intervention. Biofeedback may also be provided by health care providers, who follow a set treatment and educational protocol.

Complementary and Alternative Medicine

Complementary and alternative medicine is a term used to describe a broad range of treatment modalities, a number of which are generally accepted and supported by some scientific literature, and others which still remain outside the generally accepted practice of conventional Western Medicine. In many of these approaches, there is attention given to the relationship between physical, emotional, and spiritual well-being. While CAM may be performed by a myriad of both licensed and non-licensed health practitioners with training in one or more forms of therapy, credentialed practitioners should be used when available or applicable. Although CAM practices are diverse and too numerous to list, they can be generally classified into five domains:

- **Alternative Medical Systems:** These are defined as medical practices that have developed their own systems of theory, diagnosis and treatment and have evolved independent of and usually prior to conventional Western Medicine. Some examples are Traditional Chinese Medicine, Ayurvedic Medicine, Homeopathy, and Naturopathy.

- **Mind-body Interventions:** These include practices such as hypnosis, meditation, bioenergetics, and prayer.

- **Biological-based Practices:** These include herbal and dietary therapy as well as the use of nutritional supplements. To avoid potential drug interactions, supplements should be used in consultation with the authorized treating physician.

- **Body-based Therapy:** Included in this category are the practices of Yoga and Rolfing bodywork.

- **Energy-based Practices:** Energy-based practices include a wide range of modalities that support physical as well as spiritual and/or emotional healing. Some of the more well-known energy practices include Qi Gong, Tai Chi, Healing Touch and Reiki. Practices such as Qi Gong and Tai Chi are taught to the patient and are based on exercises the patient can practice independently at home. Other energy-based practices such as Healing Touch and Reiki involve a

practitioner/patient relationship and may provide some pain relief. Tai Chi may improve range of motion in those with rheumatoid arthritis.

Maintenance Management

Successful management of chronic pain conditions results in fewer relapses requiring intense medical care. Failure to address long-term management as part of the overall treatment program may lead to higher costs and greater dependence on the health care system. Management of CRPS continues after the patient has met the definition of maximum medical improvement (MMI). MMI is declared when a patient's condition has plateaued and the clinician believes no further medical intervention is likely to result in improved function.

Maintenance care is based on principles of patient self-management. When developing a maintenance plan of care, the clinician should attempt to meet the following goals:
- Maximal independence through the use of home exercise programs or exercise programs requiring special facilities (e.g., pool, health club) and educational programs.
- Patient self-management and self-applied treatment.
- Pain management emphasizing initiation of active therapy techniques.
- Periodic reassessment of the patient's condition as appropriate.

Supplemental Information

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Complex Regional Pain Syndrome
Post-Test

1. Which of the following is NOT a common clinical feature of CRPS? (p. 4-5)
    A. Allodynia
    B. Hyporeflexia
    C. Edema
    D. Dystonia

2. CRPS most often presents following a _____. (p. 6)
    A. systemic viral infection
    B. chronic low grade fever
    C. trauma to an extremity
    D. mild to moderate concussion

3. Prolonged limb immobilization and reluctance to move by the patient are risk factors for CRPS. (p. 7)
    A. True B. False

4. Widespread extremity pain that does not fit an obvious anatomic pattern is almost always CRPS. (p. 8)
    A. True B. False

5. CRPS is a clinical diagnosis based on _____. (p. 9)
    A. patient symptoms and signs elicited on physical examination
    B. the presence of elevated blood histamine levels
    C. decreased action potentials of peripheral nerves
    D. psychological and emotional responses to interview questions

6. It is recommended that patients diagnosed with CRPS be referred for a full psychosocial evaluation. (p. 12) A. True B. False

7. Which test is commonly utilized to assess for signs of CRPS? (p. 13-15)
    A. MRI
    B. Triple Phase Bone Scan
    C. PET Scan
    D. Myelogram

8. Which of the following is NOT a test used for measuring autonomic function? (p. 15)
    A. Nerve Conduction Velocity (NCV)
    B. Infrared Resting Skin Temperature (RST)
    C. Resting Sweat Output (RSO)
    D. Quantitative Sudomotor Axon Reflex Test (QSART)

9. Which of the following occurs during Phase 1 of CRPS treatment? (p. 18)
    A. Referral to a multidisciplinary treatment program
    B. Initiation of aggressive psychotherapy
    C. Trial sympathetic blocks
    D. Pain control and appropriate mobilization

10. Interdisciplinary programs are the gold standard of treatment for individuals with chronic pain who have not responded to less intensive modes of treatment. (p. 19)
    A. True B. False

11. Which of the following is NOT an active therapy used to treat CRPS? (p. 25-29)
    A. Stress loading
    B. Mirror visual feedback
    C. Sequential actualization
    D. Work conditioning

12. In most cases, analgesic treatment of CRPS should begin with _____. (p. 35)
    A. Opioids
    B. Tricyclics
    C. Anticonvulsants
    D. Acetaminophen, aspirin, and NSAIDS

13. Which of the following invasive therapies is no longer recommended for the treatment of CRPS? (p. 38)
    A. Spinal cord stimulation
    B. Sympathectomy
    C. Stellate ganglion block
    D. Lumbar sympathetic block

14. Individuals with CRPS can use biofeedback to self-regulate which of the following? (p. 40-42)
    A. Skin temperature
    B. Heart rate
    C. Electrodermal response
    D. All of the above

15. Which of the following is NOT one of the domains of CAM practices? (p. 42)
    A. Mind-body interventions
    B. Biological-based practices
    C. Biosensory therapies
    D. Energy-based practices

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