Occupational Health Practice Resource

Conservative Care Evidence Summary

2025 Industrial Insurance Chiropractic Advisory Committee

Washington State Department of Labor & Industries

Conservative Care Options for Work-Related Foot and Ankle Conditions

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Purpose and Intended Use

This resource was developed by the Industrial Insurance Chiropractic Advisory Committee (IICAC) of the Washington State Department of Labor and Industries. It provides concise summaries of published clinical and scientific literature regarding utility and effectiveness of commonly used conservative care approaches for work-related foot and ankle conditions; history, examination and special studies, recommendations for supportive, manual, and rehabilitative care including practical clinical resources (useable without licensing/charge in practice for non-commercial use). It is intended to inform care options and shared decision-making. High-level information on invasive treatments is included for informational purposes for conservative care providers and not intended as a treatment guideline for such interventions. This document is not a standard of care, claim management standard, nor a substitute for clinical judgment in an individual case. This practice resource does not change L&I coverage or payment policy, nor does referencing of a research study imply a given procedure is a covered benefit.

A comprehensive search of available scientific literature on conservative assessment and intervention procedures for foot & ankle conditions was conducted by the Policy, Practice, and Quality (PPQ) Subcommittee of the IICAC and department staff during Spring 2024. Literature was reviewed, assessed for relevance and quality and summaries were drafted by consensus of the subcommittee with expert content input from consultants and reviewers, including the department's Industrial Insurance Medical Advisory Committee and selected relevant professional societies in May-June 2025. An updated draft was posted for public comment and was revised and approved for distribution by the IICAC and department in October 2025. This resource is expected to be updated periodically by the IICAC. Interested parties are encouraged to submit new published scientific reports for consideration for future revisions.

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

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PRACTICAL APPLICATION POINTS

Causation: Work-related foot and ankle conditions result from an identifiable injury. With the possible exceptions of metatarsal stress fracture and fat pad syndrome, conditions related to repetitive stress are unlikely to ever be occupational.

Imaging: Using the Ottawa or Bernese rules to determine indications for x-ray to rule in ankle fractures significantly reduces unnecessary (negative) films.

Evaluation and Diagnosis:

- Stability tests may have limited utility due to inadequate reliability and validity. However, expert opinion encourages stress testing for ligament damage.
- Achilles tendon rupture may typically be determined clinically with calf squeeze and palpation without need for MRI.

Outcome Measures: Functional improvement should be determined using relevant validated functional tracking instruments at baseline and follow up.

Prognosis: Low grade sprains, acute tendinosis, and forefoot pain, typically have a rapid initial response to conservative care and resolve within a few weeks. Higher grade sprains, high ankle sprains, and chronic conditions such as chronic plantar pain may take substantially longer to resolve.

Treatment: Early mobility and weight bearing to tolerance facilitates a better and faster response for lower grade sprains. However a short period of immobilization yields faster and more sustained recovery from higher grade sprains.

- **Manual techniques** (mobilization, manipulation, soft tissue work) plus exercise (eccentric stretching) offer better outcomes than exercise alone or electrophysiological modalities for sprains and tendinosis.
- **Exercise:** Eccentric exercise facilitates recovery for tendinosis. Neuromuscular exercise may reduce recurrence of ankle sprains. Supervised exercise may offer marginal benefit to home programs for higher grade ankle sprain recovery.
- **Physiotherapeutic modalities** do not add significant benefit for recovery from most foot and ankle conditions.
- **Shoe inserts** in general may assist in comfort and recovery for foot and ankle injuries but there do not appear to be advantages for custom made products over off-the-shelf versions.

Work-Related Foot and Ankle Conditions

- Ankle sprains are a common work related injury.
- Fractures, Achilles tendon rupture, hallux rigidus, and some tendinopathies (with onset closely following a work trauma) may also result from occupational exposures.
- Plantar and heel pain are common complaints, however, causation has rarely been associated with work exposure.
- Pre-existing conditions unlikely to be caused by workplace exposure include biomechanical problems (e.g., pronation/supination), chronic ankle instability, and some pain conditions associated with peripheral neuropathies.
- Interventions are individualized for patients, all treatments and support for injured workers need to be directly related to the accepted work-related condition.

Evaluation Summary

- Determination and thorough documentation of work-relatedness of foot and ankle conditions is crucial for acceptance of an occupational foot or ankle condition, particularly where onset is not a direct result of an identifiable work injury.
- Rule-out potential urgent conditions requiring specialist attention (e.g., fracture, dislocation, tendon rupture, syndesmosis injury, 3rd degree sprains).
- Rule out infection, vascular compromise, neoplasms, metabolic red flags
- Rule-in mechanical components prior to initiating manual care.
- Document lower extremity function (e.g., validated instruments) at baseline and at regular follow-up (e.g., 2-3 week intervals).

Intervention Summary

- Evidence supports 'low tech' approaches such as early mobilization, eccentric exercise, manual therapies, and NSAIDs for most straightforward foot and ankle conditions (sprains, tendinopathy, forefoot pain).
- Recovery is typically rapid from sprains (other than high ankle) and most forefoot injuries. Tendinosis and plantar pain tend to respond slower.
- Severe injuries should be managed initially by specialists due to potential difficulty to identify complications and complexities.
- Consider reassessment and specialist consult if there is inadequate response within 3-4 weeks of conservative care.

Typical Interventions and Approximate Response Thresholds

0-2 wks

Assessment

- Patients with red flags or persistent severe pain should be referred to a specialist for urgent evaluation.
- **Uncertain mechanical etiology, severe pain/restriction:** rule out fracture and dislocation; expect some early measurable improvement w/ combined active exercise and manual work within patient tolerance.
- **Known mechanical etiology:** expect early significant improvement for low grade sprains, tendinosis, etc, however recovery may be delayed in chronic and more severe conditions.
- **Early:** Re-assess pain/function within 2-3 weeks of beginning care.

Manual Interventions

- Combined mobilization, initial active and passive exercise, and soft tissue work typically reduce pain and improve function for mechanical foot/ankle problems. Treatment frequency reported in trials typically 2-3 times per week.

Modalities/Self Care

- Full immobilization for severe conditions and fracture: R/MICE* to tolerance initially for most other foot and ankle conditions.
- Consider home exercise to tolerance.
- Physiotherapeutic modalities may not be particularly helpful.
- NSAIDs and analgesics may be helpful for initial pain control.

3-6 wks

Response

30-50% improvement in function scores is considered meaningful clinical change.

- **Good Improvement:** Function and weight tolerance improves measurably and perceptively. Continue and emphasize self-care.
- **Limited improvement:** Conditions likely to respond slowly include Grade III sprains, tendinoses, Achilles tendon rupture, hallux rigidus, high ankle sprain. Measureable change should be documented.
- **Inadequate improvement:** Worsening or no change in function (e.g., higher score on FAAM or SEFAS). Consider additional diagnostics, specialist consultation. If only small improvement, consider change in intervention (e.g., supervised exercise, more intense manual work).

Manual Interventions

- Incrementally increasing intensity of manual techniques within patient tolerance is advisable. In absence of meaningful functional improvement, consider modification of methods.
- Consider incorporation of exercises (e.g., range of motion, eccentric and balance approaches).
- Supervised exercise may be beneficial with slower responding conditions (e.g., Grade III sprains, Achilles tendon rupture, hallux rigidus, high ankle sprain capsulitis).

7-8 wks

- **Demonstrable improvement should be evident.** Inadequate response warrants consideration for evaluation by foot and ankle specialist.
- **Good improvement:** At or near pain free, nearly full function. Transition to self-care, periodic follow-up assessment.
- **Inadequate improvement:** Pain & function limitations persist, minimal improvement. Consider specialist referral.

Beyond 8 wks

- **Resolution:** Most foot & ankle injuries generally should achieve tolerance of weight bearing and normal walking.
- **Good improvement:** Most acute mechanical foot and ankle problems should resolve fully. Improvement in function should be significant and measurable in severe sprains.
- **Inadequate improvement**: Consider additional diagnostics, specialist consultation.

Foot & Ankle Progress Checklist

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

Assessment / Progress

Initial Intake
Document tasks, mobility, and ADL/work limitations.

Work limitation:

- ☐ Off work
- ☐ Weight restriction:_______
- ☐ Activity limits: ___________
- ☐ Weight-bearing work tolerance: ___________ hrs

Function Score (e.g., FAAM, SEFAS)
Baseline: ____________

Pain Interference w/ activity:
None Total
0 1 2 3 4 5 6 7 8 9 10

Baseline (check all that apply):

- ☐ Difficult weight bearing
- ☐ Unable to walk normally
- ☐ Activity limited by pain
- ☐ ________________________

Discuss Recovery
Normal healing times, activity restrictions, symptom management, and timelines.

Assess Functional Recovery
Reassess pain interference, mobility, functional scores and outcome measures.

Plan
Discuss treatment options, approaches, and referrals.

Assess Functional Recovery
Decreased pain, increasing function, returned to work. Update outcome measures.

Incrementally Increase Activity
Goal to return to normal work activities and daily routines

Good Improvement

- Progression of uncomplicated foot/ankle problems (e.g., Grade 1sprains) is typically ~50% improvement in pain and function within first 2 weeks and fully resolved within 8 weeks.
- For tendinosis 30-50% improvement in pain and function scores within first month can be expected.
- Low grade sprains respond very quickly to conservative intervention. Grade III sprains, Achilles tendon rupture, hallux rigidus, and high ankle sprain may have significantly delayed response.

Inadequate improvement

- Reassessment for red flags, further diagnostics, and specialist consultation is warranted in non-responding cases.
- Consider specialist consult for apparent low grade traumatic injuries if only minimal improvement is seen within first month.

Resolution or referral
By this time symptoms should be under control, most activities are normal. If not, surgical referral is indicated.

Occupational Foot and Ankle Assessment Summary

Occupational Foot and Ankle Conditions

Nature of foot and ankle disorders

- Urgent and serious medical conditions – infection, vascular compromise, neoplasms, metabolic conditions (e.g., gout, diabetes)

- Urgent mechanical conditions – fractures, third degree ankle sprains, syndesmosis injury, tendon ruptures (Achilles, tibialis anterior or posterior, peroneal), dislocations
- Mechanical conditions – ligamentous strains, subluxation, soft tissue disorders
- Neurological conditions – peripheral neuropathy, radicular pain, sclerotomal radiation, paresthesia (Note: trauma and fracture may also involve significant neurological compromise)

Clinical presentation [1-3]

- The most common foot and ankle injuries include inversion sprains, stress fractures, and lateral foot trauma leading to peroneal tendinosis, fifth metatarsal fracture, or cuboid subluxation.
- Simple sprains may be associated with various ligament ruptures and/or fractures, thus careful evaluation of the mechanism of injury, follow-up, and reassessment and special studies may be needed with inadequate or sluggish recovery.
- Foot and ankle conditions may present with a number of signs and symptoms including pain, swelling, stiffness, weakness/sensation of "giving out", discoloration, popping/crepitus, locking, paresthesias, and/or numbness.
- Most foot conditions are biomechanical in nature and nearly all foot and ankle conditions have biomechanical impacts. Footwear, work surfaces, postural adaptations, and concurrent biomechanical problems in the knee, hip, or back may impact foot function, stability, and/or symptoms.
- Vascular compromise, peripheral and radicular neuropathies of the back and lower extremities may manifest as foot complaints. Diabetes, myelopathy (usually canal stenosis), proximal trauma and other factors can contribute to sensory deficits with long term consequences that can contribute to, or exacerbate, injury.

Work place exposure: work injury types

- Direct trauma (e.g., blunt force; crush injuries, stubbing toes – 5th toe most common; sudden first toe dorsi/plantarflexion)
- Plantarflexion/inversion injury – most common ankle sprain typically impacts anterior talofibular and calcaneofibular areas
- Dorsiflexion/eversion injury – typically impacts deltoid ligament area (medial); talar dislocation may result when severe
- Calcaneal injury/heel pain associated with landing from a jump
- Twisting injury (e.g., "ski-boot" injury) frequently associated with distal tibia and fibula fractures and/or diastasis

Work place exposure: occupational disease

- When activities outside of work may also contribute to foot and ankle conditions, case law requires establishing that the workplace activities contributed to the development or worsening of the condition on a more-probable-than-not basis compared to the risks in everyday life. (Dennis V. Dept. of Labor & Industries, 1987) This can be particularly relevant when considering repetitive stress (e.g., prolonged standing, working on a hard surface) as a potential contributor to a foot and ankle condition.

Diagnostic corroboration

- History (e.g., mechanics of exposure - trauma, assessment of contributing factors, concurrent conditions).
- Pain localization – symptomatic area typically identifies affected structures and should correlate with exposure onset
- Plain film imaging may be helpful to assess for:
  - Osseous damage/fracture with substantial trauma and when swelling and tenderness immediately follow an injury.
  - Instability with special bilateral stress views (under anesthesia) assessing the inter-tibiofibular talar space.
  - Non-mechanical etiology such as tumor or infection.
- More severe sprains may create instability that over time could lead to damaged joint surfaces and degeneration.[4]

History – Diagnostic/Severity Indicators

Patient Presentation

Pain location and tenderness

- Determine where pain is located (ankle, toes, midfoot, hindfoot, medial or lateral, dorsal or plantar)

- Immediate pain and swelling following a sprain injury suggest Grade 2 or 3 damage. (Milder Grade 1 injuries may not develop pain and swelling for several hours, or until the next day).
- Pain above ankle joint may suggest tibiofibular syndesmosis involvement.
- Sharp pain in the distal calf region (particularly with a history of a loud pop) suggests Achilles tendon rupture.

Mobility

- Stiffness, looseness, crepitus should be assessed as should associated deformities (e.g., those related to rheumatoid conditions)
- Inversion and eversion sprain typically tolerate weight bearing.
- Increased pain directly above ankle joint with weight bearing is typical of tibiofibular syndesmosis injury.
- Ligamentous laxity may be suspected if looseness with passive movement can be demonstrated compared to the unaffected side.

Onset

- Sudden – Clarify the following:
  - Positional (inversion, eversion, dorsiflexion, plantar flexion, rotational)
  - Trauma (direct, blunt force, sudden load, e.g., from a jump or crush injury)
- Gradual/prolonged – Assess:
  - Repetitive loading (stress fractures, plantar pain e.g., ‘fallen arches’)
- Insidious – Consider:
  - Non-mechanical causes (unexplained erythema, swelling, elevated tissue temperature, pain at rest) warrant consideration for specialist referral.
  - Degenerative changes
- In all cases, determine what tasks and activities attended onset:
  - Specific triggering incident/accident
  - Usual work task/activity
  - Unique work task/activity

Age

- Instability may be a more substantial problem in older individuals.
- Joint degeneration is associated with normal aging as well as the sequelae of trauma to a joint.

History – Prognostic Indicators

Risk Factors for Developing Foot and Ankle Problems

Several factors have been reported to predispose individuals to developing foot and ankle problems including:

- Prior participation in athletics is reported to increase risk of ankle injury.
- History of previous ankle injuries are associated with increased risk of ankle sprain.
- Older individuals may have more degeneration and instability.
- Obesity and deconditioning are associated with many lower extremity mechanical conditions.
- Individuals with concurrent conditions such as diabetes, osteoarthritis, auto immune disease, deformities, cerebral palsy, and multiple sclerosis appear to have a higher incidence of foot and ankle problems.

Risk Factors for Prolonged Disability

Some of the above factors also correlate with greater likelihood of prolonged disability with foot and ankle conditions including:

- Prior ankle injuries
- Older age, obesity, general deconditioning

- Psycho social factors such as low recovery expectations and/or avoiding most any activities due to fear that it will aggravate the injury

Clinical Examination – Inspect/Observe/Palpate

Observation

Skin changes (e.g., erythema), temperature, and deformity should be noted and quantified where possible. Detailed attention to location and extent of size differences should be given with circumference measurements, photographing of bruising, use of skin-marking, etc. Such baseline information can inform progress as well as consistency of patient's subjective complaints. Objective findings include: [1, 5]

- Swelling
- Atrophy
- Deformity

Palpation

Tissue consistency, specific location of tenderness, and temperature should be assessed and ideally compared to the unaffected side. This baseline should be carefully assessed to serve as a comparison at follow-up. Palpation of the Achilles tendon may be particularly helpful in identifying full rupture, but less so for partial tear.[6]

Neuro-vascular Assessment

Peripheral pulses, temperature, trophic skin changes, sensation along peripheral and radicular nerve distributions, reflex symmetry, and strength symmetry should be documented.

Clinical Examination – Functional Deficit

Range of Motion

All injuries: Active range of ankle motion including dorsi-flexion, plantar-flexion, inversion, and eversion may be observed for symmetry with unaffected foot and pain on movement can help localize affected structures. Ankle dorsiflexion is clinically important for assessing and monitoring ankle sprains and fractures. Taking the mean of three lunge tests has been reported to be a reproducible method for quantifying weight bearing dorsiflexion.[6, 7]

- The lunge test is performed by aligning the big toe and the calcaneus on a tape measure on the floor adjacent to a wall. The patient lunges forward to contact the knee to the wall. The distance between the wall and big toe where both the big toe and calcaneus maintain contact with the floor represents the measure. Execution is iterative to find the distance at which this can be done within patient tolerance. This process is repeated three times and the mean of the three measurements is used to establish baseline and progress over time.

Hallux Rigidus: Also of clinical utility is metatarsal-phalangeal (MTP) flexion and dorsiflexion, particularly with pain and stiffness at the big toe suggestive of hallux rigidus.

Qualitatively, passive movement that is pain free compared to active movement suggests contractile tissue involvement. Stability and laxity is typically compared qualitatively to the unaffected side and adjacent MTPs. Utility and evidence regarding systematic laxity tests are described in the section below on provocation tests.

Strength

Careful muscle strength testing can be particularly helpful in identifying nerve damage that could result from an occupational injury.

- Painful resisted contraction typically suggests irritation or damage to the muscles and/or tendons involved.
- Asymptomatic weakness compared to an unaffected side suggests a neurological etiology and is more likely useful as differentiation for foot and ankle origins. Inability to dorsiflex the ankle (or sustain dorsiflexion against resistance) implicates

tibialis anterior muscle weakness that may be associated with L4/5 motor innervation. Extensor digitorum muscles are also reflective of L4/5 supply. Weakness associated with big toe dorsiflexion may implicate the extensor hallicus longus primarily attributed to L5/S1 distribution. Inability or weakness to stand on the toes implicates an S1 distribution.

- Peroneal nerve palsy may manifest as mild to complete dorsiflexion/eversion weakness. A history of contusion along the peroneal trajectory (including twisting injuries involving stretching and/or direct trauma to the outer leg) should flag careful consideration of this possibility.
- An acute foot drop following injury may be important to address early (e.g., with application of an ankle and foot orthosis until function returns) as it can result in equinus contracture.
- Peripheral nerve damage from injury or diabetes, rheumatoid arthritis, and muscle/tendon ruptures of the Achilles tendon or rarely the tibialis posterior may also be associated with weakness.

Functional Disability Questionnaire

There are a number of validated foot and ankle function questionnaires that may be used to establish baseline functional status and progress with treatment over time. When possible, a version in the worker's most fluent language should be used. Translations are available for most tools in many languages.

- **Self-reported Foot and Ankle Score (SEFAS)** – A 12-item questionnaire based on the New Zealand Total Ankle Questionnaire (NZTAQ) that has been validated against other instruments (FAOS, SF-36, and EQ-5D) for responsiveness in forefoot, midfoot, hindfoot, and ankle disorders.[7, 8]
- **Foot and Ankle Ability Measure (FAAM)** – A revised version of the FADI, including a sports subscale, with a few questions modified or removed to improve the survey's psychometric properties.[9-11]
- **Foot and Ankle Disability Index (FADI) –** A scale with 26 elements of routine daily activities, each rated on a 5-point difficulty or pain level scale. In addition, an optional sport module addresses 8 elements associated with common athletic activities. The scale has been validated and appears especially useful for ankle instability.[9, 10, 12]
- **Foot Function Index (FFI) -** Developed to measure the impact of foot pathology on function in terms of pain, disability and activity restriction. [13]
- **Victorian Institute of Sport Assessment - Achilles Questionnaire (VISA-A) –** An 8-question scale covering domains of pain, function, and activity validated for severity against two other clinical severity measures and reported reliable in a well done systematic review. [14, 15]
- **Total Ankle Replacement Questionnaire (TARQ)** – A simple 12-question scale directed at assessing total ankle replacement outcomes has been validated as a predictor of longer term success and failure rates from the procedure. [16]
- **American Orthopedic Foot and Ankle Society (AOFAS)** scales and sub-scales – AOFAS ankle scales have been popular since the 1990 due in part to their promulgation by the society but have not been as well validated or as straightforward to use as alternatives. [17] The subjective portions of the scale have been shown to be comparable to other quality of life (QoL) measures. [18]
- **Foot and Ankle Outcome Score** – A 42-question scale focusing on foot and ankle disability assessing pain, related symptoms, quality of life, function in recreation, and activities of daily living.[19]
- **Cumberland Ankle Instability Tool (CAIT)** – A 9-question self-report questionnaire that focuses on symptoms of instability during several physical tasks. Some studies have validated as a tool to discriminate individuals with or without chronic ankle instability. [20, 21] However, it does appear to predict likelihood of re-sprain.[22]

Pain Interference

Specific attention to how a patients' pain interferes with their ability to perform usual activities has been shown to be useful in predicting chronicity for low back and other musculoskeletal problems, particularly in injured worker populations. A fast and simple approach to track the impact of the patient's pain on their function could be a simple anchored 0-10 scale such as: [23, 24]

In the last two weeks, how much has your ankle pain/problem interfered with your daily activities? (Use a scale from 0 to 10, where 0 is "no interference" and 10 is "unable to carry on any activities")

Clinical Examination – Provocation - Relief

Achilles Tendon Rupture Tests

Calf Squeeze Test (Thompson, Simmonds-Thompson Test): With the patient prone and the affected leg bent 90°, or seated with the knees flexed and feet hanging free, the calf is squeezed to assess if the foot plantar flexes. The absence of any flexion indicates Achilles tendon rupture, however, plantar flexion does not rule out partial ruptures. Sensitivity (96%) and specificity (93) have been reported as high. [6]

Knee Flexion Test (Matles Test): In the prone position, the patient actively flexes the knee of the affected side through 90°. If the foot dorsiflexes or remains neutral throughout the range, rupture is suspected. Sensitivity (88%) and specificity (85%) are good. [6]

Palpation Test: Simply palpating the Achilles tendon along its entire course can determine if the tendon is intact. However, sensitivity reduces the older the rupture is.[6]

Ligament Stability Tests

Anterior Drawer Test: The drawer test appears to have some limited ability to identify significant ligamentous laxity. Manually stabilizing the lower leg with the knee slightly flexed, the calcaneus is cupped and pulled forward. Laxity compared to the opposite foot is thought to be indicative of tearing or loosening to the anterior talofibular ligament. Positive likelihood ratios of 1.2 and 1.4 are low. Negative likelihood ratios were 0.66 and 0.41. [25-27]

Talar Tilt Test: Calcaneofibular ligament stability is usually assessed by stressing the ankle into inversion. Both clinical and arthrometer laxity testing appear to have poor overall diagnostic value for evaluating chronic ankle instability as stand-alone measures. Laxity testing to assess chronic ankle instability may only be useful to rule in the condition. [28]

Directional Stress Tests: The foot may be stressed in several additional directions to assess stability including side to side (Transverse), inversion, eversion, and posterior directions. The assumption is that laxity of ligaments can be assessed, however diagnostic accuracy studies are sparse and of low quality.

Vertical Stress (Lachman) Test: Stabilizing the proximal metatarsal and elevating the related digit dorsally may help assess the integrity of the plantar plate ligaments. Translocation of the digit greater than two millimeters is thought to be suggestive of plantar plate rupture.

Tibialis Posterior Integrity

The tibialis posterior muscle inserts on the navicular and is involved in supporting the arch as well as contributing to standing and walking on the forefoot. Acute falls involving external rotation and eversion of the ankle may induce tibialis posterior muscle or tendon damage. Rupture or dysfunction is usually associated with pain in the medial foot area and may result in flattening of the arch and foot deformity.

Heel Rise Test: Heel rise involves most of the calf muscles. When the patient raises their heels (standing on toes) the heels should invert symmetrically. Lack of heel inversion may be a flag for tibialis posterior rupture.

Syndesmosis Tests

Syndesmosis Squeeze Test: At the mid-shaft region of the lower leg, the tibia and fibula are gently squeezed together. If this produces pain at the ankle, the possibility of a high ankle sprain increases, particularly with a history of onset such as landing on the feet. Pain production at the proximal fibular during this maneuver is suggestive of a proximal fibular (Maisonneuve) fracture which may be associated with substantial ankle injury.

External Rotation Test (Kleiger's Test): Pain produced in the distal leg while dorsiflexing and externally rotating the foot (while stabilizing the lower leg) is also indicative of high ankle sprain. An inability to hop, syndesmosis ligament tenderness, and the dorsiflexion-external rotation stress test (sensitive) may be combined with pain out of proportion to the injury and the squeeze test (specific) to arrive at a high-level of suspicion. [29]

Fat Pad Tests

Although there are no published reliability or validity studies, fat pad syndrome can be distinguished using anatomical location as the key feature. Pain and tenderness are found in the middle of the heel. When the fat pad is supported on either side and pressure is reapplied, the pain is decreased. This is distinguished from plantar fasciitis where pain and tenderness are more often at the medial aspect of the calcaneus rather than the middle.

Functional Ability Testing

Combined Functional Ability testing: Functional ability measures can include: isokinetic strength, joint position sense (moving foot in to a particular position after training via a positioning instrument), one leg standing, single limb hopping course (mix of level and inclined sections), single maximal hop test, and triple maximal hop test, and six meter hop for time, among others. This research suggests that combining tests for sensorimotor control and proprioception with isokinetic inversion and eversion strength testing may be a reliable indicator of function. [30]

Special Studies

In general special studies such as laboratory tests or imaging need not be considered initially in the absence of red flags such as significant trauma, sub-dermal penetration, significant redness and increased temperature. With inadequate recovery after a few weeks of conservative care, special studies such as imaging, may be helpful.

Electro-diagnostic Studies

Electrodiagnostic (EDS) studies are not particularly helpful in acute management of foot and ankle disorders. Tibial nerve entrapment (e.g., tarsal tunnel syndrome) itself is not an indication for EDS unless the condition has been refractory to conservative care.[31] Additionally, peroneal and sural nerves may be injured in ankle sprains. Although sensory testing on clinical examination should be adequate to assess this, EDS objectifies such damage, if necessary.

Imaging Studies

Imaging for foot and ankle conditions may be useful in some circumstances. A key issue when considering imaging is to anticipate how the result of an imaging study would modify a conservative care trial. For most pain and restriction conditions associated with a workplace exposure, imaging should only be considered if the condition does not respond to 4 weeks of conservative treatment. Circumstances where imaging should be considered include[1, 32]:

- Acute, severe trauma (blunt force, landing on feet, abnormal shape/suspicion of dislocation).
- Non-mechanical pain (unrelenting pain at rest, constant or progressive symptoms and signs, pain not reproduced on assessment-particularly if patient has history of cancer, enlarging mass, unexplained deformity, pain at multiple sites, age > 50, pain at rest, unexplained weight loss).
- Suspicion of infection (red skin, fever, systemically unwell, history of immunosuppression, penetrating wound).
- Substantial activity and/or work restriction lasting beyond 4 weeks.
- Failure to respond to conservative care by 4 weeks (e.g., no change, worsening, increasing disability).

The American College of Radiology publishes evidence-based condition and circumstance appropriateness criteria for imaging studies which can be accessed on their website: Appropriateness Criteria

Plain Film

Radiographs of patients with simple foot/ankle trauma, usually are not indicated. Substantial reduction of negative ankle x-rays can result if any of the conditions of the Ottawa ankle rules is met.[33] Production of pain with the application of indirect fibular stress, medial malleolar stress, or compression stress of the mid and hind foot (Bernese Ankle Rules) has also been reported to predict fracture. [34]
Ottawa Rules for acute risk of fracture:

1. Bone tenderness at the posterior region (distal 6 cm) of the medial or lateral malleolus; or

2. Inability to bear weight on the injured foot (at the time of injury and for at least four steps at time of presentation). [35]

The decision to obtain x-rays can also be informed by the mechanism and severity of injury and how it relates to the specific location of the problem the patient presents with. The Ottawa and Bernese Rules may be particularly helpful in lower grade sprains and trauma, and even when negative, a foot injury that is not showing any improving within a week or so may warrant reconsideration for imaging. The rules are not useful for individuals with diminished sensation. Patients with a lot of lateral swelling and bruising following an ankle sprain may be at increased risk of lateral talus process fracture, and significant tenderness at the proximal fibular head may raise suspicion of fracture in that region.

Plain film radiography may be useful for assessing:

- Achilles tendon insertion problems
- Symptoms caused by blunt trauma
- Retro-calcaneal bursitis
- Suspected fractures (e.g., malleolar, distal fibula and talar dome)
- Syndesmosis separation (high ankle sprain; requires comparison with unaffected side)[36]

Plain film radiography is not useful for assessing any of the following unless fracture is suspected:

- Plantar conditions or heel pain
- Ankle sprains

Usual plain film series include

- Ankle pathology – 3 view series (AP, mortise and lateral views)
- Foot pathology – 3 view series (AP, oblique, and lateral views)
- Calcaneal pathology – 2 view series (axial and lateral)

Advanced Imaging

Advanced imaging includes magnetic resonance imaging (MRI), computed tomography (CT), diagnostic ultrasonography (US) and scintigraphy (bone scans). These should typically be reserved for cases where conservative care has failed to resolve the problem. Generally, plain film and MRI are preferable to CT scans for most non-responsive foot and ankle problems.

MRI is generally considered useful for evaluating

- Achilles tendon involvement (suspected rupture, tendinosis, retrocalcaneal bursitis, paratendon tissues). However, for rupture, basing surgical decisions of clinical findings alone have been reported to be more sensitive than MRI findings. [37] Additionally, reduced wait time for surgery and fewer additional procedures based on false positive MRI findings were reported.
- Refractory tarsal tunnel syndrome
- Syndesmosis Injury[36]
- Articular cartilage damage (persistent ankle pain, locking, clicking, swelling increases suspicion)
- Some suspected occult or stress fractures particularly of the talus, calcaneus and metatarsals
- Differentiating tissues and degree of damage (e.g. metatarsophalangeal sprain versus plantar plate rupture)

CT is helpful in visualizing:

- Distal leg and ankle fracture
- Midfoot fracture or dislocation (Lisfranc injury)

US may be helpful for:

- Assessing fluid accumulation in the retrocalcaneal bursa
- Distinguishing paratendon disorders from tendinosis

- Ultrasound may detect tendon rupture and ligament damage and has the advantages of assessing structures dynamically. Similar points outlined for MRI would apply. Although it is lower cost than MRI, it is highly operator and anatomy dependent, thus can be highly variable.

Scintigraphy may be helpful for:
- Identification of occult or stress fractures but involves significant total body radiation exposure

Diagnostic Categorization

General Diagnostic Classification

Diagnostic conclusions for occupational foot and ankle conditions require elements of workplace exposure related to condition onset, presentation, and clinical findings. There are numerous foot and ankle conditions that manifest in pain and discomfort that result from normal weight bearing and other pre-existing conditions which confound adjudication in workers' compensation claims. Quality population-based epidemiological studies identifying work-relatedness of most foot and ankle conditions other than sprain are lacking in the literature. It is important to carefully document any workplace exposures that are believed to directly cause or contribute to the foot and ankle condition.

General Categorization for Care Triage

- **Urgent and serious medical conditions** – infection, vascular compromise, neoplasms, metabolic conditions (e.g., gout, diabetes) warrant consideration for specialty referral
- **Urgent mechanical conditions** – fractures, tendon ruptures, dislocations, severe sprains, and compartment syndrome warrant consideration for specialty management
- **Mechanical conditions** – sprains, strains, subluxation, and soft tissue disorders are typical examples warranting consideration for conservative management
- **Neurological conditions** – peripheral neuropathy, radicular pain, sclerotomal radiation, and paresthesias warrant close monitoring under conservative care and may warrant consideration for specialty co-management.

Ankle Sprain Grading (by degree of swelling, pain and bruising)

- **Grade 1 (1st Degree)** – Overstretching with some microscopic damage to ligament fibers. Pain and swelling may arise after a few hours. Weight bearing is tolerated; Splinting/casting not indicated; rehab exercise to tolerance indicated.
- **Grade 2 (2nd Degree)** – Partial tearing of ligament tissue. Pain and swelling typical soon after injury. Loosening of affected joint may be demonstrable compared to contralateral ankle. Ecchymosis possible. Temporary splint (e.g., air splint) immobilization usually appropriate; incrementally increasing mobilization, range of motion, stretching and strengthening exercise indicated.
- **Grade 3 (3rd Degree)** – Complete/large ligament tear. Significant pain, swelling and instability evident following injury. Ecchymosis typical. Immobilization appropriate; incrementally increasing rehabilitation work indicated. Depending on extent and severity of tear, surgical reconstruction may be needed. May involve dislocation.

Note: Weight bearing is tolerable in most inversion and eversion sprains, but may be more problematic in high ankle sprains.

Categorization by Likelihood of Occupational Exposure

<u>Potentially Occupationally-Related Conditions</u>
- **Achilles tendinosis, tendinopathy, and retrocalcaneal bursitis** – All three terms refer to painful conditions in the region of the Achilles tendon and heel.[6, 38] Tendinopathy is a general term to characterize general pain and/or swelling of a tendon. Tendinosis has replaced the term "tendonitis" due to the lack of histological signs of inflammation. Because these conditions are also frequently related to chronic vascular and degenerative changes, it is important to document a clear linkage of a

workplace exposure to the onset of the condition. Standardized terminology and definitions have been proposed for Achilles tendinopathies.[39, 40]

- ***Mid-portion Achilles tendinopathy:*** a clinical syndrome characterized by a combination of pain (2-7cm proximal to the calcaneal insertion), swelling and impaired performance. It includes, but is not limited to, the histopathological diagnosis of tendinosis.
- ***Achilles paratendinopathy:*** an acute or chronic inflammation and/or degeneration of the thin membrane around the Achilles tendon. There are clear distinctions between acute paratendinopathy and chronic paratendinopathy, both in symptoms as in histopathology.
- ***Insertional Achilles tendinopathy:*** located at the insertion of the Achilles tendon onto the calcaneus, bone spurs and calcifications in the tendon proper at the insertion site may exist.
- ***Retrocalcaneal bursitis:*** an inflammation of the bursa in the recess between the anterior inferior side of the Achilles tendon and the posterosuperior aspect of the calcaneus (retrocalcaneal recess).
- ***Superficial calcaneal bursitis:*** inflammation of the bursa located between a calcaneal prominence or the Achilles tendon and the skin.

- **Achilles tendon rupture** – Identifiable work trauma with significant load to tendon can induce an Achilles tendon rupture which is typically accompanied by audible pop and sudden loss of plantar flexion. Causation is poorly understood; tendon degeneration from repetitive micro trauma and limited vascular supply has been postulated as contributing factors.

- **Ankle sprains** – May result from inversion, eversion, rotational trauma and be of varying grades. Compression trauma (e.g., a jump) may induce a distal tibia-fibula syndesmosis injury (high ankle sprain).

- **Forefoot pain** (metatarsophalangeal sprain, metatarsalgia, sesamoid injury) Metatarsophalangeal joint sprains are graded similarly to ankle sprains above (Grade 1, 2, 3) and diagnosed by history (flexion or extension trauma) and presentation (localized pain exacerbated by movement). Plantar plate rupture is a specialized case involving hyper dorsiflexion of ligaments under the metatarsophalangeal joints that may result in instability and longer term hammer toe deformity. Sesamoids are small accessory bones that help anchor the flexor hallucis tendons. Loading that stresses these tendons (e.g., pushing off with the big toe, an extensive increase in loading/amount of walking or running with unsupportive footwear) may irritate the attachments to the sesamoids. Foot mechanics and structural factors unrelated to a work exposure (e.g., cavus, plantar flexed 1st ray) may also aggravate sesamoids.

- **Peroneal and posterior tibial tendinosis, tendinopathies** - Like the Achilles tendon, the lateral (peroneus brevis and longus) and medial (posterior tibialis) tendons from lower leg muscles may also become injured and painful as a result of acute trauma such as a fall or jump and may be associated with calf muscle strain or other ankle ligament sprain. Tendinosis in these structures tends to be less common in typical acute work injuries; they may be more closely associated with extended ankle use such as in marathon running. Careful history of the mechanics of the injury along with palpation for tenderness along the tendons' course helps differentiate which tendons are involved. Differentiate tendonitis, dislocation, and splits/tears.[41-43]

- **Plantar pain** (arch pain, heel pain, plantar fasciitis, fat pad syndrome, high arches) – There are a number of causes of posterior and plantar foot pain. Diagnoses such as plantar fasciitis have poorly understood etiologies. Because of this, and due to the absence of medical literature linking the onset of chronic plantar pain to specific work activities, it can be a challenge to make a case for work-relatedness. However, direct trauma to the hindfoot such as a sudden heel strike on a sharp object can traumatize soft tissue in the arch, or under the calcaneus (fat pad).

- **Trauma-induced degenerative joint disease** (hallux rigidus, turf toe, traumatic arthritis) – Traumatic arthritis is common with jamming of the first toe usually into dorsiflexion traumatizing the first metatarsal or metatarsal-talar joints. Characterized by localized pain in the affected joint, it is typically provoked with dorsiflexion of the big toe. A joint so traumatized may experience accelerated degeneration but this may appear as a longer term sequelae of recovery from injury. When hallux rigidus is believed to be directly caused by a previous work exposure, it would be expected that a previous workers' compensation claim for an injury to the affected big toe would have been accepted. Rather than a new claim, the degenerative condition is best addressed as a reopening of the original claim. Post-traumatic arthritis can occur following significant ankle, hindfoot and midfoot trauma. This may present a number of years after the initial injury. Because the initial workplace injury is generally more significant, the link between the DJD and the initial injury is relatively easy to establish. The relationship should be evident when taking the patient's history. Although uncommon compared to ankle sprains, displaced tibial plafond (pilon) fractures, calcaneus fractures, talar body or neck fractures, midfoot fracture/dislocations (Lisfranc injuries) frequently result in post-traumatic arthropathy years later . Typically, such fractures require a higher energy injury mechanism such as a fall from a height, car accident, or crush injury.

- **Stress fractures** (e.g., March fracture) – The best-known etiology of stress fractures of the foot relates to extensive, prolonged walking or running in unconditioned individuals (such as from marching in new military recruits and long distance runners). Fractures are typically tiny partial cracks in weight bearing bones of the foot that are difficult to visualize radiographically. Diagnosis is usually based on the presentation of localized pain that worsens following an identifiable exposure history. The second metatarsal is frequently involved due to its longer length (leverage) and its central role in absorbing impact to the ball of the foot during foot strike. Plantar plate tearing (fibrocartilage under the metatarsal-phalangeal area) may also result from sudden hyperextension, but is usually progressive due to pre-existing foot mechanics such as congenitally short 2nd or 3rd metatarsals. Although bone scans are definitive for stress fracture diagnosis, they are not recommended unless conservative management fails. It may be important to differentiate stress fractures due to work exposures from those related to pre-existing mechanical stress from deformities such as a bunion.

- **Subluxations of foot and ankle** (e.g. cuboid, navicular, talus, metatarsals) – Typically attributable to an identifiable mechanical exposure, subluxations of tarsal joints and metatarsals are characterized by discrete pain/discomfort and limited motions in the foot, usually without swelling.

- **Tarsal tunnel syndrome** – An uncommon condition involving entrapment or stretching of the tibial nerve or one of its branches. The tarsal tunnel is formed by the distal tibial malleolus, calcaneus, and flexor retinaculum ligament. In addition to the tibial nerve, the posterior tibial artery and vein traverse it as well as posterior tibialis, flexor digitorum longus, and flexor hallucis tendons. Trauma to the area may induce edema, however structural/functional conditions, particularly hyperpronation, may stress structures in the tunnel which may confound the work-relatedness of the condition.

- **Trauma-induced nerve syndromes** (Morton's neuroma, metatarsalgia, complex regional pain syndrome) – Many nerve syndromes of the foot are insidious in nature and any suspected rationale for work-relatedness should be carefully documented. However scarring and post-traumatic degenerative change may lead to peripheral nerve entrapment or inflammation. Most common are Morton's neuroma and metatarsalgia. Morton's neuroma is thought to stem from irritation of nerve fibers on the plantar surface of intermetatarsal ligaments and has been associated with palpable painful nodules in the region. Metatarsalgia has also been attributed to irritation or trauma to ligaments under the plantar surface, particularly transverse ligaments. Much less common, and of varying degrees of controversy, are complex regional pain syndromes (CRPS). CRPS may be a rare, insidious, chronic pain condition that affects a limb (CRPS I, reflex sympathetic dystrophy), or, more commonly, develops subsequent to an identifiable trauma (CRPS II, causalgia).[44] The condition is associated with severe pain, joint stiffness, hypersensitive skin (allodynia), skin-color changes (ranging from redness to bluish or white), temperature changes and limb swelling. Most cases are mild and self-limiting, but a small number may become severe and chronic. Central and peripheral nervous system anomalies are believed to be a primary mediator for the condition; however genetic predisposition and autoimmune conditions may contribute or influence the condition. L&I's Work-related CRPS guideline [45] delineates diagnostic criteria regarding when the condition may be considered as occupational, including that another work-related condition for the same foot/ankle has been previously accepted.

Potentially Pre-existing (confounding/complicating/non-occupational) Conditions

- **Achilles tendinosis, tendinopathy, retrocalcaneal bursitis and other tendinosis** – Unless onset is closely correlated with a specific occupational injury, these conditions are most likely pre-existing to occupational conditions (e.g., resulting from obesity or anatomic anomalies that impact biomechanics).

- **Associated systemic conditions –** Diabetes is an increasingly common affliction associated with peripheral neuropathies in the foot related to vascular deficiencies. Diabetics may have slower healing times associated with wounds and tissue injury. Other systemic conditions that may manifest in the distal lower extremities include thrombolytic vascular conditions, auto-immune disorders, and arthritis such as gout and rheumatoid arthritis.

- **Associated neurological conditions** (e.g., radiculopathy, peripheral neuropathy) – These conditions may manifest with foot and ankle symptoms and may or may not be concurrent with an occupational foot condition.

- **Chronic ankle instability** – Ankle instability is associated with histories of pre-existing exposure (such as previous sports injury). Differentiating contributions from a current work-related exposure from those associated with the pre-existing condition can be challenging. Careful and thorough history taking as well as assessment of the unaffected side and review of available prior clinical records can be helpful.

- **Osteochondritis dissecans** – An uncommon condition involving damage (desiccation) to articular cartilage associated with microfracture of subchondral bone resulting in loss of blood supply leading to necrotic bone formation. It is more common in juveniles and adolescents and may be associated with repetitive trauma (e.g., sports) as vulnerable cartilage and bone matures. Avascular necrosis may be associated with growth plates in children (e.g. Kohler's disease of the navicular tarsal). Damage to the articular cartilage of the superior surface of the talus may occur in ankle trauma (e.g., more severe sprains). Cracks in the cartilage itself, or in the subchondral bone may contribute to delayed recovery or show up as an intra-articular fragments over time.

- **Pronation** (pes planus) and **supination** (pes cavus) – Propensity to pronation or supination may be functional or structural and is associated with variant foot mechanics that predispose one to mechanical stresses that may contribute to foot complaints. These conditions are typically hereditary or pre-existing conditions that would not be considered as occupationally related. However they may influence some treatment and rehabilitation decisions (e.g., braces or supports) for occupational injuries. Additionally, in more substantial trauma and fracture, resultant deformity may induce these or other mechanical states such as peroneal tendinopathy where the condition itself could become a sequela of an accepted occupational condition.[46]

Workers' Compensation Assessment Issues

Causation & Work Relatedness

Exceptionally clear clinical justification for specific work exposure(s) is essential for fair and timely decisions in nearly all workers compensation claims. Typically, an identifiable incident or incidents on the job shortly before the conditions onset would be expected. The concept of cumulative industrial trauma (such as prolonged standing) as an etiology of foot and ankle conditions does not generally have support in the medical literature.[31, 47] To be accepted by the department as a cumulative trauma leading to an occupational disease, specific additional legal requirements must be met (RCW 51.08.100). Generally, pain and other manifestations of both industrial injuries and occupational diseases become evident within 3 months of an inciting event. In a situation where a foot and ankle condition reported for the first time more than 3 months after a patient is first seen by a provider, it is important that the clinical rationale for its relationship to work be very well documented.

To establish a diagnosis of an occupational disease, all of the following are required:

1. **Exposure:** Workplace activities that contribute to or cause the specific foot and/or ankle condition(s) arising naturally and proximately from employment, and
2. **Outcome:** A diagnosis of a foot and ankle condition that meets reasonable diagnostic criteria with objective findings such as those delineated in this resource, and
3. **Relationship:** For a foot and ankle condition to be allowed as an occupational disease, the provider must document that, based on generally accepted scientific evidence, the work exposures created a risk of contracting or worsening the condition relative to the risks in everyday life, on a more-probable-than-not basis (Dennis v. Dept. of Labor and Industries, 1987.

More information on filing a claim for an occupational disease, including billing information, can be found in: https://www.lni.wa.gov/forms-publications/F252-117-000.pdf

- Acute workplace trauma has been linked to tendinosis, tenosynovitis, fractures, and ligament strains. Stress fractures have been reported with substantial increases in walking and weight-bearing activities (for example, a worker who normally has a sedentary job that is required to spend a day moving heavy equipment over long distances, or engage in tasks that required prolonged running for which they were not conditioned).[31]
- No well-designed studies have documented a relationship between work activities, other than a specific trauma, and degenerative joint disease.[31]
- Most of the literature regarding causation of foot and ankle problems relates to sports activities, not occupational exposure. Where there may be associations, they are often associated with agriculture and heavy labor industries.[48] Further, non-occupational factors are strongly associated with foot and ankle problems including a person's weight, recreational activities, gender, age, foot mechanics and shape, footwear, and concurrent disease status (e.g., diabetes) confounding delineation of occupational contributors. [3, 49]
- An observational study of cold weather training among military recruits reported an increased risk of Achilles tendinopathy. [50]
- The etiology of seven foot and ankle disorders commonly involved in compensation litigation (hallux valgus, interdigital neuroma, tarsal tunnel syndrome, lesser toe deformity, heel pain, adult acquired flatfoot, and foot and ankle osteoarthritis) was reviewed in one study using a logistic framework based on Koch's postulates to analyze the potential for cumulative industrial trauma to cause foot pathology. [47] In none of the disorders that were analyzed, could cumulative industrial trauma reasonably be considered a distinctive factor in a large proportion of cases, or be a condition that consistently occurs in particular occupations (as is the case in a condition such as hypothenar hammer syndrome). These conditions often occur from intrinsic foot mechanics, regardless of exposure factors. The evolutionary adaptation of the foot to prolonged ambulation and the absence of industrial demands that significantly alter such mechanics on feet likely account for reduced vulnerability of the foot to industrial repetitive motion disorders compared to the upper extremity.
- A systematic review of prevalence studies reported that 24% of older and middle age adults in the general population report foot pain problems and another 15% report ankle pain. Prevalence increased with advancing age and among women. [51]

Assessment of Re-exposure on Return to Work

Time since injury is a strong predictor of return to work (RTW) after foot and ankle injuries. In a small study, about a third of injuries had RTW by 3 months.[52] Early referral and intervention seems to be correlated with better outcomes. In a military setting, this return to work rate and reduced re-injury rate peaked with those who received physical rehabilitation within the first month of care. When rehab was delayed, recurrence rates and treatment length went up.[53] In return to sports, low Ankle-GO scores lead to significant risk of recurrence in ankle sprains, so rehabilitative completeness may be beneficial to assess at 2-3 months to predict at-risk individuals.[54] While appropriate exercise-based rehabilitation reduced this risk of recurrence.[55]

Physical Capacity & Work Restrictions

No studies were identified with current search strategies regarding how to best to determine current work restrictions and physical capacity. Expert advice is to proceed slowly with graded increases and build on success over time. Whenever possible, work with therapists to provide skilled assistance in work-related motions and modifications.

Conditions

General Approaches for Common Work Related Syndromes

Ankle Sprains (inversion, eversion, rotational, syndesmosis)

First week post-injury typically includes protecting the ankle and controlling any swelling, but current thought and research supports rapid incorporation of pain-free activity and motion of the affected ankle. Delay in rehabilitation has been linked to the likelihood of experience recurrence of injury.[56]

- **Grade 1**: Modified pain-free activity, Ice, Compression, Elevation (MICE)
    - Avoid walking or weight bearing on affected ankle initially
    - Apply ice immediately to reduce swelling. Apply for 20-30 minutes, 3-4 times daily.
    - Compression dressings, bandages or ace-wraps may be considered to help support the injured ankle.
    - Regular elevation of the affected foot during the first 48 hours can help reduce swelling.
- **Grade 2**: MICE plus an immobilization brace/splint
- **Grade 3**: MICE and significant immobilization (e.g., short leg cast or brace) may be indicated for 2-3 weeks. Short periods of non-weight bearing (e.g., crutches) may be appropriate particularly if significant pain occurs with weight bearing. Permanent instability may be a residual from a Grade 3 sprain. Surgery is rarely indicated.

Second through third weeks should focus on restoring range of motion, strength and flexibility within patient tolerance Thereafter gradually returning to regular activities that do not involve twisting the ankle can begin along with more specific rehabilitation and strengthening exercise. Activities that require sharp, sudden cuts and turns (e.g., sports like tennis or basketball) may require several weeks to months for full recovery. The degree of injury guides specific treatment approach. Remain attentive for bone tenderness at the posterior aspect of medial or lateral malleolus, or inability to bear weight on the injured foot (Ottawa ankle rules) which can be indicative of fracture as can pain with indirect fibular stress, medial malleolar stress, or compression stress of the mid and hind foot (Bernese ankle rules). If any of these are present, imaging may be warranted.

Rehabilitation is used to help to decrease pain and swelling and to prevent chronic ankle problems. Ultrasound and electrical stimulation may also be used as needed to help with pain and swelling. At first, rehabilitation exercises may involve active range of motion or controlled movements of the ankle joint without resistance. Water exercises may be used if land-based strengthening exercises, such as toe-raising, are too painful. Lower extremity exercises and endurance activities are added as tolerated. Proprioception training is very important, as poor proprioception is a major cause of repeat sprain and an unstable ankle joint. Once pain-free, other exercises may be added, such as agility drills. The goal is to increase strength and range of motion as balance improves over time while avoiding re-injury.

Achilles tendinopathies, tendinosis, retrocalcaneal bursitis

Achilles tendinosis and retrocalcaneal bursitis are characterized by pain during rest or activity at, or above, the heel posteriorly. Either can result from direct trauma or stress to the ankle from sudden increased activity such as jumping or running with inadequate conditioning. In general, acute, inflammatory tendonitis may be considered to exist in someone without a history of pain in the region when pain in the insertion area follows a work exposure. Tendinosis is the term characterizing subacute, chronic, or episodic insertional pain. Effective management of the inflammatory phase is believed to help prevent progression to tendinosis. [57]
Management can be organized as follows:

- **Initially:** Conservative treatment would be aimed at alleviating symptoms, loosening muscle belly and associated muscle groups, graded return to activity involving loading of the tendon, possibly including supportive bracing during the healing process and while returning to tendon loading activities. Gradual progressive stretching of the calf muscle groups and tendon reduce tension to the tendon. Eccentric calf muscle training appears to have the most consistent literature support. [58] Typical conventional management often includes frequent icing, heel lift to reduce stress on tendon, a trial of oral NSAIDs or analgesics (acetaminophen) in the first few weeks following onset. Steroids and opioids should be avoided.

- **Post inflammation:** Rehabilitation interventions should include eccentric loading exercise and stretching of the gastrocnemius and soleus muscles 1-2 times per day. Alternating heat and ice application may increase microcirculation in the area. The role of lifts or orthotics is unclear. Extracorporeal shockwave therapy has been reported to be of benefit in refractory chronic AT, but not in acute/sub-acute cases. [59, 60] Resolution typically occurs within 4-12 weeks, depending on the nature, severity and degree of injury. In refractory cases recovery can take up to six months.
- **Onset over existing tendinosis:** Acute onset of consistent pain at work in someone with a history of short or long term intermittent pain in the Achilles tendon region may occur with or without visible inflammation and may be managed and expected to respond similarly to a new episode.

Retrocalcaneal bursitis may be concomitant with Achilles tendinosis and exhibits a similar presentation of posterior heel pain exacerbated by standing on tiptoes, typically accompanied by redness and tenderness over the back of the heel. Treatment is essentially the same as for Achilles tendinosis, and the bursitis should resolve within a few weeks. Because glucocorticosteroid weakens connective tissue, and the significant amount of stress on the ankle can put the Achilles tendon at greater risk of rupture, injection in the region of the Achilles tendon should be avoided. [61] If employed as a last resort, it should only be attempted once and any stretching on the tendon (e.g., calf stretching exercise) should be avoided for about two weeks. For refractory cases, low level evidence suggests endoscopic surgical techniques meet with higher patient satisfaction than open surgical approaches, however well-done effectiveness studies have not been done. [62]

Achilles tendon rupture

There is moderate quality evidence for both surgical repair and non-operative management with casting and functional bracing for Achilles tendon rupture. Generally, an early surgical consultation should be obtained for all cases of complete Achilles tendon rupture and a treatment plan should be initiated as soon after the injury as possible, particularly with non-operative management.[63]

- Surgical repair with immobilization (casting or functional splinting) followed by rehabilitation is the typical approach for Achilles tendon ruptures and appears to be associated with a slightly lower re-rupture rate than functional splinting alone. [64, 65] However functional splinting may be used for individuals with contra-indications for surgery and who may have minimal physical demands. [66, 67]
- Overall, there appear to be no major differences in function after 12 months between surgical and non-surgical approaches, with non-surgical approaches avoiding potential surgical complications but having slightly higher re-rupture rates. [68-70]
- In both cases, tendon healing can be slow and scar tissue is of poorer quality and strength than undamaged tendon. Both approaches are associated with lower high-demand performance long term.
- The use of surgical approaches appears to be declining as a result of better quality comparative trials.[71]

Posterior tibial, peroneal tendinosis or tendinopathy

Peroneal and posterior tibial tendinosis usually heal well with conservative management, although may progress slowly. Conservative management includes MICE, myofascial work, and gentle stretching in associated muscles. Limiting walking until pain subsides (usually a few weeks) is useful and ankle bracing or lateral heel wedge may be helpful. Especially severe or painful cases may benefit from a more rigid support such as a walking boot. Gradually increasing muscle training should be deferred until pain is reduced and should be done only to tolerance. Cross training approaches for mobility and exercise allow affected tendons rest time which may assist recovery. Severe and refractory cases may warrant imaging (ultrasound, or MRI) to assess tearing and need for surgical consultation.[72] As with other tendinosis, corticosteroids should be avoided and have only short term effects.[41, 72-74]

Plantar pain (arch pain, heel pain, “plantar fasciitis/fasciosis,” fat pad syndrome, high arches)

Pain in the heel region is common and may follow many different exposures, or are idiopathic. Arthritic, neurologic, traumatic, or systemic conditions may account for symptoms, however biomechanical foot considerations are thought to account for the majority of complaints. [75] Significant pain when walking after waking up or being sedentary is characteristic of plantar and heel pain. It is typically self-limiting. If presenting concurrently with unexplained lower back pain, consideration of spondyloarthropathy may be warranted, particularly in younger individuals. Persistent or recurrent plantar heel pain has many names including plantar fasciitis, runner's heel, calcaneodynia, calcaneal periostosis, and heel spur syndrome. Symptomatically it typically refers to pain on the bottom of the arch or hind foot region. Tissue thickening of the plantar fascia is a principle criterion. The diagnosis and etiology of plantar fasciitis remain controversial, particularly as related to occupational causation. Attribution has been made to excessive running, obesity, pronation, and prolonged standing, but data are insufficient to definitively determine risk factors. [76, 77]

- Common conservative interventions include: Activity modification, rest, ice, deep tissue work in the plantar fascia, stretching exercise, shock absorbing orthotics or shoes, a variety of physiotherapeutic modalities, night splints, and oral NSAIDs.[78-80]
- Corticosteroid injections are frequently employed with plantar pain. However, it is important to distinguish fat pad syndrome from other plantar pain syndromes due to the concerns that injecting corticosteroid can diminish any remaining fat pad. [61] Heel cushioning is the preferred method of treatment for fat pad syndrome.

Tarsal tunnel syndrome

Tarsal tunnel syndrome is a very rare condition. Severe pronation trauma or significant direct trauma would be expected modes of onset. Conservative management is usually successful and includes a variety of approaches[81-83]:

- Activity modification with R/MICE is the typical initial approach when trauma acutely triggers symptoms of tibial nerve entrapment.
- Manipulation, mobilization, nerve glide exercise, and corrective footwear or orthotics are commonly employed interventions. The condition typically resolves without problems.[1, 84]
- Orthoses including medial heel wedge may be helpful. Arch support and controlled ankle motion walkers may be valuable in some cases.[83]
- For cases that do not resolve within a few weeks, nerve conduction studies and/or MRI can be considered to determine if the posterior tibial nerve is compromised.
- Oral NSAIDs or glucocorticosteroid injections are commonly used for entrapment neuropathies. However, use of injected steroids has long been discouraged due to potential for nerve and connective tissue damage. [85] No studies specific to steroid injection for tibial nerve entrapment were identified with our search strategy.
- Surgical treatment for tarsal tunnel appears variable and is best done in a small group who have refractory symptoms.[86] Open tibial nerve decompression approaches increasingly being replaced by endoscopic approaches. Endoscopic tarsal tunnel decompression has been reported to be a safe procedure with a low rate of recurrence or failure and allows for near-immediate ambulation. [87]

Foot and ankle joint dysfunction/subluxation (e.g. cuboid, navicular, talus, metatarsals)

Frequently described in manual medicine, osteopathic, and chiropractic literature, primarily as case reports and series, foot and ankle joint dysfunction/subluxations might be best characterized as findings associated with various other conditions and precipitating injuries such as ankle and hind foot sprains. [88-91] However, although a standardized case definition is not well developed, the frequency of diagnostic attribution, its mechanical nature, and association with other common work-related foot and ankle conditions warrants its mention.

- Extremity manipulation is the most described treatment and has been shown to be effective for such inciting events and conditions as ankle inversion sprain (Grade B evidence short term and Grade C long term), plantar fasciitis (Grade B evidence short term and Grade C long term), metatarsalgia, hallux limitus, and foot/ankle proprioception/balance problems. [1, 92]

Forefoot pain (e.g., metatarsalgia, metatarsophalangeal sprain, plantar plate rupture, sesamoid injury)

Pain in the forefoot region can be associated with a number of structures and differentiation can often be challenging. They generally can be grouped as acute (e.g., sprains, contusions) and chronic (e.g., overload, callusing), the latter situation requiring careful documentation of the clinical rationale for being the result of a workplace exposure. Additionally, regardless of structure involved, there is typically great similarity in conservative management.

Metatarsophalangeal (MTP) joint sprains are graded similarly to ankle sprains above (Grade 1, 2, 3) and diagnosed by history of joint trauma typically in flexion or extension. Presentation involves localized pain, usually exacerbated with passive or active movement and swelling may be evident. Plantar plate (ligaments on the plantar aspect of the metatarsal phalangeal joints) disruption may result from substantial dorsiflexion trauma (commonly from tripping) and may result in instability and longer term hammer toe deformity. It is most common in the second metatarsophalangeal joint. [93]

- Initial management typically includes MICE, NSAIDs, and mobilization.
- Taping may be used to limit motion after acute inflammation is controlled, with splinting or casting reserved for higher severity sprains.
- Increasing passive and active mobilization and joint manipulation may be helpful in speeding full recovery The big toe is the most commonly affected (turf toe).
- Lower grade sprains usually resolve within a week and require little to no activity modification. Grade 2 injuries may need to avoid sustained weight bearing for up to two weeks (crutches or walker), and several weeks of restriction may be appropriate for severe sprains. A general guide of 50-60° pain-free dorsiflexion is often used to recommend unrestricted loading/activity. Non-weight bearing with crutches is typically needed with severe sprains or plantar plate ruptures.
- Conservative measures for suspected plantar plate rupture include 4-6 weeks of cross-over taping to plantarflex the affected digit (to reduce stress on the ruptured plate) along with a cushioning pad and compressive strapping to improve alignment. Particular orthoses/orthotics are sometimes used to reduce stress on the plate to dorsiflex the metatarsals while allowing plantar flexion of the digits. The aim of conservative care is to realign the affected digit and plantar plate preventing or slowing progressive deformity.
- Surgical repair may be considered based on the severity of acute injury (with extremely loose vertical stress test) or signs of hammer deformity. MRI arthrogram may be needed to assess degree of rupture as the ligaments approximate when relaxed and regular MRIs are negative.

Trauma-induced Sesamoiditis: Sesamoids are accessory bones that variably occur as anchoring attachments for the flexor, adductor, and abductor muscles of the big toe. They may become inflamed or irritated with direct trauma to the ball of the foot (e.g., landing from a big jump, extensive loading when pushing off with the big toe) and may be concurrent with stress fractures and sprains of the metatarsals.[94] Presentation usually involves pain and tenderness on the plantar surface of the first metatarsophalangeal joint which is exacerbated on dorsiflexion of the big toe.

- Acute management may include MICE and NSAIDs. Sustained management is usually focused on reducing direct irritation of the region with strategies such as taping, in-shoe padding, sturdier footwear, and/or modifying hard work surfaces.

Trauma-induced degenerative joint disease

The first toe is the most common arthritic joint in the foot, and hallux rigidus is the second most common foot condition after bunion. It is usually associated with hallux valgus, and has its highest prevalence in the 30-70 year age range. It is often of unknown etiology, however, may be associated with prior traumatic workplace injury to the big toe. In such instances, documented attribution of a specific work exposure is important. For example, a previous acute injury (such as at least a Grade 2 metatarsophalangeal sprain) might be expected to have been accepted as a workers' compensation claim, and would be expected to present unilaterally. The presentation involves dorsal pain upon loading, especially pushing off for walking. Presentation should also include, stiffness, palpable exostosis, pain with axial compression and rotation (axial grind test), occasional synovitis, and decreased motion on motion palpation (particularly dorsiflexion). It can be expected to be accompanied by positive X-ray findings (spurring and joint narrowing). At least four of the previous findings should be present to make the diagnosis. Higher energy work injuries (e.g., fall from a height, car accident, crush injuries) that resulted in displaced tibial fracture, calcaneus fractures, talar body or neck fractures, midfoot fracture/dislocations (Lisfranc injuries) may result in delayed-onset, post-traumatic arthropathy and should be readily liked to original injury.

- Non-surgical treatment typically includes cryotherapy, contrast baths, mobilization, manipulation, NSAIDs, and/or footwear modification (or orthoses with a Morton's extension) that minimizes 1st MTP joint motion. Corticosteroid injections are also used. Surgical removal of bone spurs (cheilectomy) may be considered in refractory cases and joint fusion (arthrodesis) is sometime recommended for severe cases. Joint replacement (arthrodesis) is also used, but usually only in older individuals without high functional demands on their feet.

Stress fractures ("march" fracture)

Metatarsal stress fractures tend to occur after an identifiable period of increased higher impact activity (e.g., prolonged walking or running). They typically present with continuous achy, forefoot pain that exacerbates on weight bearing and is relieved by rest. Tenderness, bruising and/or swelling may also be present.

- Stress fractures of the middle metatarsals are usually self-limiting within 6-8 weeks using pain control including ice and elevation early on along with rigid footwear. Fractures outside the joint can usually be treated with early functional therapy.[95] However, if refractory, or with an occupation placing high demand on the feet, the use of crutches or a walking cast may be necessary.
- Outer metatarsals, particularly the 5th are more likely to be acute fractures from a more direct trauma (such as kicking, the foot getting stepped on or twisting while landing from a jump). Avulsion of the styloid process at the proximal base of the 5th metatarsal is the more likely with a twisting or inversion sprain while a transverse fracture near its base (Jones fracture) is usually associated with repeated stress exposures. 5th metatarsal fractures can be managed similarly to other stress fractures, however some transverse fractures become non-unions due to blood supply limitations and stresses from where muscles attach. [96, 97]
- There can be many different locations and types of stress fractures with subtle nuances in management to ensure optimal healing. Foot and ankle specialists such as podiatrists, orthopedists, sports practitioners may be important resources in evaluation and management of foot and ankle stress fractures. Fractures in the distal joint are likely to need surgical intervention.[95]

Trauma-induced nerve syndromes (Morton's neuroma, complex regional pain syndromes)

Work-relatedness can be difficult to establish for nerve syndromes due to multiple variations in etiologies and various anatomic structures that may become associated with persistent or recurrent nerve pain.

- **Morton's Neuroma**: Presentation is typically pain on the plantar surface of the foot in the region of a middle inter-tarsal space, exacerbated by direct pressure (e.g., palpatory, shoes that are too small). Histologically it has been linked to scarring or other amorphous deposits entrapping nerve fibers coursing along intertarsal ligaments. [98] In some instances a small tender nodule may be palpated. The condition may be associated with an altered gait due to increased lateral stress on the foot to avoid painful pressure on the affected area. A previous work injury (e.g., stress fracture to an adjacent metatarsal, landing or crush injury) to the affected area would be expected to have been previously accepted for a claim. Conservative treatment includes orthotics and manipulation/mobilization.[99] A variety of infiltrative therapies appear effective including alcohol and corticosteroid injections appear to have the best outcomes.[100-102] Radiofrequency ablation may also be considered.[103]

- **Complex regional pain syndrome (CRPS):** Typically affecting a particular limb (arms, legs, hands, or feet), CRPS is a chronic pain condition that would need to be causally associated with an occupational injury or trauma to that limb. CRPS pathophysiology is poorly understood, however one form, called CRPS II, has been attributed to damage of peripheral nerves and/or the central nervous system. It is characterized by persistent mild to severe pain and is associated with changes in skin color, temperature, sweating, and/or edema in the affected region thus implicating the sympathetic as well as the somato-sensory nervous system. Symptoms and findings may be highly variable. This, along with poorly understood mechanisms, contributes to diagnostic uncertainty and resultant controversy about the condition. Vitamin C (500mg per day) administered after extremity trauma or surgery has been shown to prevent development of CRPS [104] and may be useful if begun early in onset of symptoms. Treatment approaches with evidence of benefit include CRPS-focused physical/occupational therapy including desensitization & neuromuscular re-education to improve neuromuscular function, progressive active exercise to improve blood supply and flexibility, functional goal development including weight bearing and gait training, and training in self-management including home exercise. Medications for symptom management include NSAIDs for pain control and others linked to individual presentation. Cognitive behavioral therapy may be considered for individuals with fear avoidance or psychological barriers to using the affected limb. Some cases have been documented to respond to lumbar sympathetic blocks. In refractory cases a multidisciplinary pain management program may be helpful. Early referral should be made to specialists in management of CRPS. L&I has a medical treatment guideline addressing diagnostic criteria and other issues for CRPS as an accepted occupational condition. [45] Work-Related Complex Regional Pain Syndrome: Diagnosis and Treatment

Evidence Summaries by Intervention

Early Mobilization

Ankle sprains

Early mobilization may be considered a functional intervention that includes flexible or semi-rigid ankle support and combinations of incrementally increasing active movement and weight bearing which results in less pain, greater range of motion with better function. There are a number of studies and reviews which support this approach for all grades of sprains and following surgical stabilization. [105-111] [112] However, functional braces have been associated with higher rates of post-operative complications with wound healing in surgical treatment of fractures compared to rigid casts. [113] Generally, more rapid and aggressive return to normal activity can be implemented with lesser grade sprains. There are a variety of braces, supports, boots, tapes/wraps utilizing pneumatics, gels, fabrics and plastics on the market. Head-to-head comparative studies of styles and brands of different products were not identified using the current search strategy. Most studies compared rigid casting to semi-rigid support. Utility of many studies was confounded by small samples, access to multiple co-interventions, and questionable comparison groups among other limitations.

Manipulation and Mobilization

Ankle sprains

Overall, passive and active mobilization has been shown to immediately improve one or more of: ankle dorsiflexion, pain levels, and function in acute and subacute ankle sprains. [114-123] Manipulation in addition to RICE may improve range of motion and functional measures including stride speed within a shorter time frame and may be associated with a slightly sooner return-to-work. [124] Manipulation combined with exercise has small advantages over either alone. [125, 126] The addition of soft tissue work may enhance the effectiveness of combined mobilization/manipulation and exercise. [92, 124, 127] Generally, mobilization and manipulation are often provided in combination with exercise and soft tissue work for best results. [126-128] Reasonable evidence suggests utility with plantar pain. Some low quality evidence also suggests helpfulness of these approaches for milder hallux rigidus, and tarsal tunnel syndrome, however comparative and experimental studies are lacking.

A potential clinical prediction rule may be used to evaluate patients who may not benefit from ankle manipulation or mobilization. Four variables were associated with poor responders: symptoms worse when standing; symptoms worse in the evening; navicular drop greater than or equal to 5.0 mm; distal tibiofibular joint hypomobility. Using the presence of 3 out of 4 of the variables as a clinical prediction rule for unsuccessful outcome yielded a post-test probability of success of 95%. [129]

Achilles tendinosis, tendinopathy, and retrocalcaneal bursitis

No high quality studies specifically addressing manipulation with Achilles tendinosis or retrocalcaneal bursitis were found using the employed search strategy. The rationale for joint mobilization or manipulation regarding Achilles tendinosis or bursitis would be to address mechanical restrictions in the ankle or foot that may be associated with facilitating muscle spasm/tension/dysfunction that could irritate these structures (e.g., guarding and limping contributing to soleus or gastrocnemius tightness). Some evidence is available for other regions such as epicondylosis of the elbow and rotator cuff tendinosis. [130, 131] Clinically, joint manipulation and mobilization would be used in combination with soft tissue work and exercise for which some evidence is available as noted in other sections.

Plantar pain

A large variety of conditions may contribute to or cause plantar and heel pain. A rationale similar to manipulation for Achilles tendonosis applies here with facilitating of unrestricted foot and ankle mechanical function reducing sources of irritation to soft tissue and tendon insertions. Likewise, joint manipulation is likely to be combined with mobilization, soft tissue work and exercise for the best results [132, 133] Manipulation/mobilization appears to work better in the first 6 months than with longer lasting pain. [134]

Tarsal tunnel syndrome

No useful studies were identified specifically addressing joint mobilization or manipulation for tarsal tunnel syndrome. The American College of Occupational and Environmental Medicine's (ACOEM) Occupational Medicine Guidelines [31] recommend against using manipulation for treatment of tarsal tunnel, surprisingly based on two trials of manual therapy for carpal tunnel syndrome that both reported benefit to the manual interventions. [135, 136] There does not appear to be justification to explicitly exclude joint manipulation or soft tissue work from a conservative care regimen for occupationally-related tarsal tunnel syndrome, but it would be important to demonstrate meaningful symptomatic and functional improvement within the first few weeks of care. Nerve gliding may also be beneficial form of mobilization/movement.[137]

Forefoot pain

Little evidence exists for or against manipulation for forefoot pain. A small trial of manual care (mobilization, high velocity low amplitude manipulation, intermetatarsal glide) vs placebo (detuned ultrasound) for 8 treatments over 4 weeks indicated significant improvement in pain and function favoring manual care, but the placebo group had a higher level of baseline pain.[138]

Foot and ankle subluxations

Essentially characterized by restricted or aberrant, sometimes painful, movement between joints, tarsal and metatarsal subluxation are probably more of a clinical finding than a specific occupational condition. Commonly described symptom patterns may be associated with particular tarsal or metatarsal joint dysfunction (such as sensations of apprehension or 'giving out' with tarsal or cuboid syndrome). Discomfort on particular movements or palpatory maneuvers such as squeezing metatarsals together or distracting toes may occur in metatarsal phalangeal subluxation. Neither diagnostic accuracy studies, nor high quality clinical trials were identified with search strategies, however case reports describe rapid resolution to such presentations. [88-90, 92, 139]

Trauma-induced degenerative joint disease

Several case reports and case series exist describing straightforward resolution of cases of hallux rigidus with manipulative management. [92, 139, 140] High quality trials have not been done, but due to the straightforward and rapid resolution apparent with acute or mild (e.g., uncomplicated stubbed toe) non-surgical management similar to other Grade 1 or 2 joint sprains are likely

candidates for manipulation, mobilization and exercise following initial pain control. Manipulation may be unlikely to be tolerated, nor particularly effective, in advanced (Grade 3) cases. [141]
There is some indication in small trials that manipulation/mobilization may be helpful for conservative treatment of Morton's neuroma, but evidence is not high-quality.[99]

Stress fractures

No studies were identified specifically evaluating mobilization or manipulation in the management of stress fractures. However a cohort study did explore osteopathic manipulative treatment (OMT) as a preventative measure to improve foot mechanics in distance collegiate runners followed over a 5 year period. This cohort was compared to a cohort from the previous 8 years for runners not receiving OMT. The incidence of stress fractures among males in the OMT cohort reduced from 13.9% to 1%. A minimal reduction from 12.9% to 12.0% was seen in female distance runners. [142]

Physio-therapeutic Modalities

Generally, electrical modalities (e.g., diathermy, electrical stimulation, low level laser therapy, ultrasound) do not have high quality evidence supporting their use in most foot and ankle injuries and conditions. Systematic reviews of available studies report contradictory or mixed results. [143, 144] Several systematic reviews suggest R/MICE for acute injuries with increasing use of passive movement (e.g., mobilization, manipulation) and active exercise (e.g., eccentric exercise, balance training) appear to be more helpful. [145, 146]

Ankle sprains

- Cryotherapy and compression are frequently recommended to reduce inflammation and swelling in acute ankle sprains as is initial avoidance of weight bearing and elevating the affected foot to help drain edema (Rest, Ice, Compression, Elevation or 'RICE'). However, well-done trials do not exist leaving primarily case series and consensus driving recommendations. Some studies do suggest incorporation of therapeutic exercise within the first week is useful in leading to modification of the management acronym to Modified pain-free activity, Ice, Compression, and Elevation (MICE). [105, 124]
- A systematic review of studies regarding therapeutic ultrasound for acute ankle sprain identified trials representing over 600 subjects in 5 comparisons of ultrasound to sham and 3 with other conservative interventions.[144] No significant differences in pain or function were noted with the addition of ultrasound, in fact most participants recovered fully within 2-4 weeks regardless of intervention.

Achilles tendinosis, tendinopathy, and retrocalcaneal bursitis

Tendinopathy and tendinosis are broad terms for painful conditions occurring in and around tendons, frequently associated with an exposure to excessive or prolonged loading. Histological research suggests that degenerative change, rather than inflammation, is associated with these conditions. [147] Systematic reviews have pooled data from studies on tendons in multiple body regions. The most studied tendinopathy of the foot and ankle is the Achilles tendon. Reviews generally indicate that treatment modalities aimed at controlling inflammation (corticosteroid injections, NSAIDS, and physio-therapeutic modalities such as iontophoresis, low-level laser or ultrasound) report little to no treatment effects compared to controls, or studies report conflicting results.

- Systematic reviews and meta-analysis of treatment options for tendinopathy evaluated NSAIDS, corticosteroid injections, exercise-based physical therapy, physical therapy modalities, shock wave therapy, sclerotherapy, nitric oxide patches, surgery, growth factors, microcurrent therapy, and stem cell treatment. NSAIDS and corticosteroids appear to provide pain relief in the short term, but long-term has not been demonstrated. Inconsistent results were noted for shock wave therapy and physical therapy modalities such as ultrasound, iontophoresis and low-level laser therapy. [74, 143, 148, 149]

Plantar pain

- Manual therapy for heel/plantar pain longer than 1 month seems beneficial when including calf stretching and self-mobilization of the foot and plantar fascia three times daily with manual therapy (6 sessions of aggressive soft tissue mobilization of triceps surae and plantar fascia insertion at the medial calcaneal tubercle along with rear foot eversion mobilization and general lower extremity joint mobilization of the foot ankle, knee and hip if indicated on manual assessment). Advantages were sustained across 1-6 months. [132]

Soft tissue techniques

Massage, Myofascial Release Therapy, Trigger Point, Passive Stretch

There is some effectiveness data for deeper myofascial procedures, particularly when combined with manipulation or exercise. Generally brief (5-15 minute) and more superficial treatment sessions do not appear to show substantial improvement versus no-treatment or home care differences in functional measures, but may be associated with higher perceived satisfaction, relaxation, and well-being. [150, 151] Overall, studies on soft tissue techniques are numerous, of variable quality, often fail to adequately describe technique details (e.g., superficial, deep, trigger point) and frequently focus of general factors such as sports performance, flexibility and strength, and may group interventions for a particular diagnosed condition.

Ankle sprains

- In the treatment of individuals' post-inversion ankle sprain, the addition of myofascial therapy to a plan of care consisting of thrust and no thrust manipulation and exercise may further improve outcomes compared to a plan of care solely consisting of thrust and no thrust manipulation and exercise. However, though statistically significant, the difference in improvement in the primary outcome between groups was not greater than what would be considered a minimal clinically important difference. Future studies should examine the long-term effects of these interventions in this population.[128] Outcomes of pain at rest, ankle mobility, and functional ability showed greater improvement in pain and function than those who received single interventions.

Plantar pain

- Significant benefit for combined treatment compared to other treatments was seen from 4 weeks of exercise (calf stretching and self-mobilization of the foot and plantar fascia three times daily) and manual therapy (6 sessions of aggressive soft tissue mobilization of triceps surae and plantar fascia insertion at the medial calcaneal tubercle along with rear foot eversion mobilization, and general lower extremity joint mobilization of the foot ankle, knee and hip if indicated on manual assessment). Self-report questionnaires, including LEFS, FAAM, and the NPRS showed improvement at short and long term follow-ups. [132]
- Self-stretching exercise plus manual trigger point therapy group showed greater pain, function, and mobility when compared to stretching alone after 4 weeks. [152]

Trauma-induced nerve syndromes

- Only one case report was identified describing the effect of massage therapy with a 25 year old symptomatic Morton's neuroma patient who had been unresponsive to prior conservative interventions. Six 60-75 minute sessions of weekly massage therapy combined with home stretching exercise were employed. Progressive reduction in numeric pain rating scores and change in pain character from burning and stabbing through dull and elimination were reported, including ability to engage in pain-free exercise.[153]

Exercise

Exercise therapies include any active therapy and may be directed by a healthcare professional or self-directed by the patient after appropriate training. Exercise is prescribed to improve or restore flexibility, range of motion, strength, as well as muscle coordination (normalization of muscular firing patterns, and/ or proprioceptive sense). There are many specific approaches within the physical therapy, sports medicine, and chiropractic literature with much of the work in this area focusing on larger lower leg muscles which may impact major ankle motion and stability. Exercise should be performed gradually with incremental increases in degree of motion as condition and comfort permit. Exercise typically includes at least active assisted range of motion and home based strengthening exercises. Regular incremental increases in movement distances and loading appear to be essential to successful rehabilitation.

Neuromuscular coordination/balance training is common in rehab with more robust impact on reducing likelihood of re-injury as opposed to direct recovery of injury. Most research studies for foot and ankle rehabilitation come from sports medicine and involve otherwise healthy teens and young adults. It is expected that age, general conditioning, degeneration, and concurrent disorders such as diabetes may have significant impact on recovery. Foot and ankle exercises focus on four general types:

- **General mobility:** Early mobilization, i.e., return to movement and weight bearing within tolerance, from acute injury is fairly well established. Active movement and normal weight bearing and walking should be part of patient education generally. Studies regarding early mobilization are summarized in a previous section.
- **Stretching Exercise:** Frequently directed at leg musculature, stretching aims to reduce muscle tightness that may directly cause pain, but which impacts biomechanics of foot and ankle movement as well as added stress on tendons and their insertions. Intrinsic muscles of the foot may also be a target for stretch, particularly with plantar and forefoot pain conditions.
- **Strengthening Exercises:** Regarding ankle and foot, strengthening tends to fall within two distinct approaches:
    - Concentric loading involves active contraction of a muscle against a load. Rising up on one's toes would involve concentric contraction of calf muscles (the "up" or contraction phase of the movement).
    - Eccentric loading involves lowering the load back to the starting position. A common protocol is to do a 6-week long daily program of "as tolerated" eccentric heel drops for Achilles tendinopathy.[154]

  Generally, concentric loading is more demanding in terms of forces on muscles and tendons, so for rehabilitation of injuries, eccentric approaches are typically preferred.
- **Neuromuscular (Balance, Proprioception, Coordination, and Gait) Training:** Balance training is particularly common in sport medicine and for ankle rehabilitation generally. There are many kinds of exercise ranging from using wobble or rocker boards, one-legged stands, to more sophisticated training and loading programs. Generally speaking this work has been focused on improving responsiveness of lower leg musculature to sudden load or surface changes to provide greater muscular support for chronic instability, thus particularly relevant for prevention of re-injury, more so than injury recovery per se.

Ankle sprains

Stretching exercise

- Static-stretching interventions with a home exercise program had the strongest effects on increasing dorsiflexion in patients 2 weeks after acute ankle sprains. The range of effect sizes for movement with mobilization on ankle dorsiflexion among individuals with recurrent ankle sprains was small. [145]
- Small studies have shown passive stretch of plantar flexor muscles appears to increase both strength and flexibility in healthy males compared to controls. [155]
- Short duration static stretching induced an acute improvement of speed and agility performance in healthy male subjects (using a cross over design six different stretch durations), whereas longer duration has neither positive nor negative effect. [156] Individuals of a lower speed and agility performance level appeared to be more likely to benefit by a short duration than those already exhibiting higher response times.

Strengthening exercise

Strengthening exercise, especially eccentric exercise of the calf musculature is frequently included in rehab programs for ankle injury. Although specifically studied in Achilles tendinopathy, no studies specifically evaluating strengthening for ankle sprains were identified with the current search strategy. However, several systematic reviews examining supervised rehabilitation globally were identified.

- Reviews of treatment for lateral ankle sprain concluded there was limited to moderate evidence to suggest that the addition of supervised exercises to conventional treatment leads to faster and better recovery (including return to sports activity at short term follow-up periods) than conventional treatment alone, although there may be little effect on physiologic outcomes. [157] [158] In specific populations (athletes, soldiers, and patients with severe injuries) this evidence was restricted to a faster return to work and sport only. No strong evidence of effectiveness was identified for any outcome measures.

Neuromuscular training

- Many reviews have established the role of neuromuscular training (strength, flexibility, balance, and endurance) in preventing ankle injury/re-injury in adolescent and young adult athletes. [159-162] Multi-intervention with home-based training was effective in reducing risk of lower leg injuries; balance training alone was effective in reducing ankle sprain injuries; and all exercise interventions were more effective in subjects with a history of sports injury than those without.[163, 164]
- Combining bracing or taping with functional neuromuscular training is supported to address preventative interventions effective for acute lateral ankle sprains. [165]
- Recurrence rates and costs were analyzed for ankle sprains comparing care as usual to care as usual with 8 weeks of unsupervised balance exercise, capturing costs and recurrences for both groups.[166, 167] Self-reported recurrence rates were 22% in the group adding proprioceptive training compared to 33% in the control. Mean total costs were significantly lower in the intervention group. These findings are consistent with previous studies and systematic reviews however it should be noted that research is primarily on athletes and the most robust effects appear to be preventing recurrences within a year following an acute ankle sprain. [168-170] Extrapolation for chronic instability is less persuasive.
- In older adults, Tai Chi subjects demonstrated faster times for Get Up and Go, increased stride length and time spent in single limb support at the end of intervention as compared with baseline. The balance training group demonstrated a significant increase in ankle plantar flexor power and near significant decreases in step width and step width variability. No changes in the education-only control group were observed. Although not directly relevant to recovery from work injuries, this study indicates utility for balance training in older populations, usually not represented in the available reports on younger athletes.[171]

Achilles tendinosis, tendinopathy, and retrocalcaneal bursitis

- Systematic reviews of all treatments for non-calcified, insertional Achilles tendinopathy concluded that eccentric exercises resulted in a decrease in VAS score and may perform better than concentric exercises, however, full range of motion eccentric exercises showed a low patient satisfaction compared to floor level exercises and other conservative treatment modalities without large difference in benefit.[40, 58, 172-174] One study determined that in particular, men seemed to benefit more from eccentric training than women and alternatives may warrant consideration. [175]
- Two European randomized trials have compared eccentric exercises and repetitive low energy shockwave therapy (SWT) for chronic (>6 months) mid-portion Achilles tendinopathy with fairly equal results, showing benefits to treatment over no-treatment, but fairly equivalent treatment effects compared to other interventions for SWT. No compelling rationale was established for SWT [176, 177]

Posterior tibial, peroneal tendinosis or tendinopathy

There is a paucity of effectiveness literature regarding conservative treatment specifically for peroneal or posterior tibial tendinopathy likely due to the significantly more common Achilles variety. It is reasonable to utilize similar approaches for other tendinopathies and the available studies of posterior tendon dysfunction appear to support this. Strategies include high-rep exercises, plantarflexion activities, joint mobilization, gastroc-soleus stretching and ankle stability work. [178-180]

Plantar pain

- The addition of manual trigger point therapy to a self-stretching regimen for plantar pain was favored significantly for physical function, bodily pain, general health, and emotional role scores on SF-36 and pressure pain [152]
- Exercise to stretch the calf and strengthen intrinsic foot muscles along with soft tissue mobilization, and rearfoot eversion mobilization produced superior results on standardized functional scales compared to exercise alone. [132]

Orthoses

Braces, supports (wraps, taping) corrective footwear, shoe inserts

Orthoses is a general term applied to any external device used to modify the neuromusculoskeletal system, but is commonly associated with the lower extremity. Orthotics typically refers to the 'specialty' within healthcare concerned with design, production, and application of orthoses. However, street usage of the term 'orthotics' frequently refers to shoe inserts (as opposed to braces affixed to the lower extremity).

Types of orthoses may be categorized generally as:

- **Braces and supports** – such as an air cast, boot, or device independently attached to the lower extremity utilized as a temporary measure;
- **Corrective footwear** – specially made shoes to be used on a long term or permanent basis;
- **Shoe inserts** – which may be soft, semi-rigid, rigid, or heel-lifts directed at modifying how biomechanical stresses are directed during weight bearing –standing, walking, and running- usually on a long-term basis.

Any of these types of devices may be used to effect a change in the bio-mechanics or function of the foot or ankle and/or to cushion or relieve direct stress to an affected area of the foot. Devices may be available "off the shelf" or customized, however advantages to customized versions for many applications are not well supported in the literature.

Functional devices – typically are durable (rigid or semi-rigid) and designed to facilitate normal joint function. The goal of such devices is to brace or effect a change in functional position (or prevent worsening of that position). Typically made from hard-shell or firmer materials, functional devices aim to address mechanical issues such as pronation, reduce forces contributing to arch strain (fasciitis), or post tibial tendonitis. In management of work-related conditions, such supports may be appropriate following joint fusion or repair of a torn tendon or fascia, or to correct underlying mechanical conditions that are be retarding recovery from an accepted injury.

Accommodative devices – typically are of softer materials, protecting a fixed deformity or wound (e.g., diabetic ulcers, traumatic arthritis, bony prominences, etc.) from direct irritation. The goal of such devises may include relieving pressure, increasing shock absorption, or adapting to a deformity. Examples might include filling in gaps after amputations, replacing padding when scarring or tissue loss has occurred.

Although temporary braces, supports, and some applications of heel lifts are typically employed directly for rehabilitation from an injury, corrective shoes and inserts are often directed at managing preexisting anatomic and biomechanical variants (e.g., pes planus, pronation) that may not be directly related to treatment for and recovery from an accepted occupational condition. It can be important to distinguish when an orthosis designed for permanent use is needed to directly compensate for the effects caused by an industrial injury from use designed to compensate for pre-existing conditions. For example, lifts or inserts that reduce dorsiflexion may be appropriate for recovery from work-related Achilles tendinosis, yet similar inserts correcting for a cavus deformity that was not a proximate cause of an accepted condition may not be considered appropriate, unless the deformity is a direct barrier to recovery from the injury. Substantiation of such a pre-existing condition being a barrier to recovery may provide justification for coverage in some instances; however corrective, permanent orthoses or footwear may be more appropriately addressed as part of the worker's general health care.[181]

Ankle sprain

- The use of an Aircast ankle brace for the treatment of lateral ligament ankle sprains produces a significant improvement in ankle joint function at both 10 days and one month compared with standard management with an elastic support bandage or tubular bandage and has good quality of life rankings. [182, 183]
- Severe ankle sprain patients who could not weight bear but had no fractures benefited the most from a below-knee cast in terms of pain, ADL, foot/ankle related quality of life and sports activities and a faster recovery time compared to tubular bandage,

Aircast ankle brace or Bledsoe boot. [183, 184] The Bledsoe boot conferred no significant advantage over tubular bandage and was less cost-effective.

- Although neuromuscular training as part of rehabilitation from acute ankle sprain has been shown to be effective in reducing re-injury, bracing when combined with training was shown to be superior to balance training alone in preventing recurrences (but not severity).[165, 185] Utilizing a combination was recommended for achieving best preventative outcomes with minimum burden on the patient.
- The use of foot orthotics appears beneficial for improving postural control in individuals with chronic ankle instability.[186]
- Individuals with chronic post-traumatic disabilities that affect the foot and ankle are also likely to benefit from orthopedic shoes with custom made insoles, showing improvements in dynamic stability and decreased pain levels. [187]
- Use of custom orthotic insoles does not appear to prevent lower limb overuse injuries in healthy male subjects.[188]

Achilles tendinosis, tendinopathy, and retrocalcaneal bursitis

- Weak evidence indicated that foot orthoses were equivalent to physical therapy, and to no treatment. Very weak evidence supported the use of adhesive taping alone or when combined with foot orthoses. Moderate evidence showed that the AirHeel™ brace was as effective as a calf muscle eccentric exercise program, and weak evidence showed that this intervention was not beneficial when added to a calf muscle eccentric exercise program. [189] Additionally, weak evidence indicated that an ankle joint dorsiflexion night splint was equally effective to a calf muscle eccentric exercise program, and strong evidence showed that this intervention was not beneficial when added to a calf muscle eccentric exercise program. [190]

Posterior tibial, peroneal tendinosis or tendinopathy

- Orthoses with eccentric exercise combined therapy demonstrates the most improvement in pain and function, while orthoses with stretching exercise demonstrates the least. [191]
- Use of a short, articulated ankle-foot orthosis or foot orthosis, high-repetition exercises, aggressive plantarflexion activities, and an aggressive high-repetition home exercise program that included gastroc-soleus tendon stretching showed improvements in pain and function after a median of 10 physical therapy visits over a median period of 4 months. Roughly 10% failed this conservative course and underwent surgery later on.[179]

Plantar pain

- There is mixed evidence on whether custom-made orthoses are more beneficial than pre-fabricated/over the counter orthoses with several studies concluding they may work similarly. Overall, orthoses appear to benefit patients with plantar fascia pain both in short term and long term, up to one year. There is no support for the use of magnetic insoles for plantar fasciitis.[192-194]
- When used in conjunction with stretching program, a prefabricated shoe insert is more likely to produce improvement in symptoms as part of initial treatment for plantar fasciitis. [195]
- Night splints for plantar fasciitis appear to not offer as substantial long term outcomes when used alone as compared to orthoses use.[194]

Other Non-surgical Interventions

This resource addresses conservative care, with particular emphasis on manual, active, and self-care strategies. It does not provide a comprehensive review of pharmacological evidence and management; however, a high level overview of drug classes typically employed for foot and ankle injuries is included. Additionally, a number of alternative and emerging interventions are available for foot and ankle conditions. Available published studies rarely address worker populations or activity outcomes critical to workers compensation and many new and emerging technologies may not be covered in Washington state. This holds particularly true for interventions that are not directly condition-oriented, high-cost technologies for which existing effective, and cost-effective alternatives are available, and for interventions that have been associated with safety or adverse event concerns. Inclusion here

reflects only a brief summary of retrieved evidence and is presented for educational purposes and does not imply authorization in an individual circumstance. Coverage decisions can be found at:
https://www.lni.wa.gov/patient-care/treating-patients/conditions-and-treatments/

Drug Therapy for Neuropathic Pain Conditions

Lower extremity nerve syndromes (e.g., tarsal tunnel syndrome, Morton's neuroma, and complex regional pain syndrome) may respond to drug therapy with proven efficacy for other neuropathic pain conditions. Refer to the department's coverage decision for additional information.[196]

Non-steroidal anti-inflammatory Drugs (NSAIDs)

NSAIDs are commonly used for managing foot and ankle conditions and injuries due to their effectiveness in reducing pain, inflammation, and swelling. These medications can provide significant relief, allowing individuals to manage discomfort and promote better mobility. However, their use should be carefully considered, particularly in the context of the specific condition, the duration of treatment, and the potential for side effects. For example, while NSAIDs have proven benefit in the short-term treatment of acute tendinopathy, there is conflicting evidence for efficacy in the treatment of chronic tendinopathy. Due to the potential harms, long-term NSAID use is not recommended for this indication. Conflicting data also suggests that NSAID use may delay bone healing or increase the risk for nonunion after a fracture, so caution is urged in prescribing chronic NSAID use for this indication. For localized symptoms, topical diclofenac 1% gel may be a preferable option to avoid systemic side effects of oral NSAIDs, including gastrointestinal injury, kidney toxicity, and cardiovascular events.[197-199]

Achilles tendinopathy

Because the histological nature of tendinopathies and tendinosis is not inflammatory, and because NSAIDs may have longer term deleterious effects on tendon healing, NSAIDs are generally not recommended. For pain control, R/MICE, activity modification and analgesics reflect usual medical care. [58]

Plantar pain

- The results of a single trial provide some evidence that the use of NSAID may somewhat enhance pain relief in patients with plantar fasciitis when used in conjunction with a conservative regimen that included heel-cord stretching, viscoelastic heel cup and night splinting. [200]

Injected Steroids

There is general consensus that the potential long term harm from glucocorticosteroids in or around tendons far outweigh short term benefits and use is contraindicated.[201-203] Tissue degeneration, tendon rupture, and nerve injury are among reported adverse events.[85, 204]

Opioids

Although opioids are often employed to treat severe pain, usually short term post-operatively, their use, especially beyond a one-time initial prescription, has been associated with increased disability in workers compensation.[205] Appropriateness, effectiveness of, and dosing for opioids is the subject of several guidelines. [206, 207] Literature specific to opioid use in management of foot and ankle problems is mostly directed to specific types of post-surgical management, including infusion at the surgical site. [208-210] Opioids can be effective for managing severe, acute musculoskeletal pain, such as from fractures, severe sprains, or post-surgical recovery. They work rapidly to reduce the sensation of pain and can allow for temporary relief when other treatments are insufficient. However, when it comes to chronic musculoskeletal pain, opioids are typically not recommended as first-line therapy. This is due to limited evidence for long-term efficacy and the risk of serious adverse outcomes, including dependence, addiction, overdose, sedation, cognitive impairment, endocrine dysfunction and prolonged disability. Any use of opioids in Washington workers' compensation must be consistent with L&I's Guideline for Prescribing Opioids to Treat Pain in Injured Workers[211, 212]

Autologous Blood, Autologous Conditioned Plasma, Platelet Rich Plasma (PRP) Injection

There is inadequate evidence suggesting effectiveness for autologous blood injections. The procedure is not covered under Washington workers' compensation.

Achilles tendinopathy

- A Cochrane review including randomized and quasi-randomized controlled trials on the effects of platelet rich plasma for soft tissue injuries (of the ankle and foot, elbow, knee and shoulder) and concluded that there is currently insufficient evidence to support the use of PRP for treating musculoskeletal soft tissue injuries. [213]
- Other trials conclude similar results that do not demonstrate PRP superiority to other treatments [214-219]

Therapeutic Laser

Low level laser therapy (LLLT, photobiomodulation) uses low wattage red beam or near infrared laser light to 'photostimulate' soft tissue for cellular repair. LLLT is a covered benefit under Washington workers' compensation. Although two small randomized trials were identified that suggest palliative relief may possible with LLT in Achilles tendinopathy and plantar pain in non-worker cohorts, studies addressing functional improvement or return to normal activities including work are lacking and LLLT should be used in conjunction with other therapies. [220-223]

Achilles tendinopathy

- A randomized controlled trial of 52 recreational athletes with chronic Achilles tendinopathy assigned subjects to eccentric exercise plus low level laser therapy or eccentric exercise plus placebo low level laser therapy (LLLT).[224] Low level therapy was administered in 12 sessions. At final follow up (12 weeks), the pain intensity during physical activity on the 100-mm visual analog scale was statistically significantly lower (33mm vs. 53mm) in the exercise plus LLLT group than in the exercise plus placebo group. The study concluded that low level laser therapy with eccentric exercise accelerates clinical recovery from Achilles tendinopathy.

Plantar pain

- 30 individuals with a diagnosis of unilateral plantar fasciitis were enrolled in a randomized, double-blind, placebo-controlled trial. Individuals were randomly assigned to receive low level laser therapy or a placebo for 6 weeks.[225] Sub-calcaneal pain rated on VAS improved significantly in all tests (night test and daily activities test) after LLLT when compared to the placebo group. The difference in pain relief between groups was statistically significant (after night rest P=0.000; daily activities P=0.001). Ultrasonographic appearance of aponeurosis thickness was changed pre-post in both groups but not significantly different. The study concluded that low level laser therapy may contribute to healing and pain reduction in plantar fasciitis, however functional status was not reported.

Prolotherapy

Prolotherapy (between 8-30 injections of a prolotherapy solution, e.g., 15% dextrose and 0.2% lidocaine) for lateral ankle ligaments is sometimes promoted to treat chronic ankle instability. No trials were identified evaluating the effectiveness of prolotherapy in the treatment of chronic ankle instability. Further, prolotherapy is not covered as a benefit under Washington State's workers' compensation.

Blood flow restriction training

A novel therapy with limited, but promising evidence on an investigational track. Currently limited research prevents recommendations.[226]

Acupuncture

Acupuncture is not a covered benefit in Washington State workers' compensation for foot pain. Under state law, care must be curative and rehabilitative which is operationalized as meaningful functional improvement. Although some lower level evidence exists for pain reduction, studies addressing functional improvement or return to normal activities including work are lacking. https://www.lni.wa.gov/patient-care/treating-patients/conditions-and-treatments/acupuncture-for-lumbar-conditions

Plantar pain

- In a 2001 randomized controlled trial, 53 patients with plantar pain were randomized to a treatment group (needling at the acupoint PC7) and a control group (needling at the acupoint hegu). At 6-month follow up, there was significant reduction in pain scores favoring the treatment group (22.6 ± 4.0 versus 12.0 ± 3.0, mean ± SEM), overall pain (20.3 ± 3.7 versus 9.5 ± 3.6) and pressure pain threshold (145.5 ± 32.9 versus -15.5 ± 39.4). The study concluded that acupuncture can provide pain relief to patients with plantar fasciitis and that PC 7 is a relatively specific acupoint for heel pain. [227]

Surgical Interventions

This resource is not intended to inform surgical decision-making, nor evaluate the safety and effectiveness of the procedures covered in this section. Please refer to our Foot and Ankle Medical treatment guideline for information on appropriateness of particular surgical referrals.

Workers' Compensation Intervention Issues

Employer Contact for Accommodation

This is considered a best practice in occupational health in order to facilitate effective return to work, however no studies were found specific to occupational foot and ankle conditions.

- Interviews of injured workers in Ontario with prolonged claims identified numerous system and bureaucratic issues that were significant factors in prolonging a claim, particularly systematic issues impeding implementation of return-to-work options. [228]

Administrative Interventions

Breaks, Duration

No studies on administrative intervention regarding recovery from occupational foot and ankle injuries were identified in our searches, but there is some indication that administrative practices, jurisdiction, and reporting environments may impact worker experience and recovery.[229-232]

Ergonomic Interventions Engineering Interventions, Work Site Modification, Multiple Component Interventions	No studies on work and task modification for recovery from occupational foot and ankle injuries were identified in our searches. • One narrative literature review reported on studies addressing the influence of flooring on long-term standing.[233] Most identified studies used subjective ratings of fatigue and discomfort experienced while standing in laboratory settings and report mixed and sometimes conflicting results and studies were inconsistent in duration. Subjectively, softer floors were associated with lower reported leg and back discomfort compared with a hard floor. However, no consensus emerged regarding influence on any physiological or biomechanical measures.
Work Rehabilitation Interventions	• Workplace-based rehabilitation intervention was more effective than conventional clinic-based rehabilitation in terms of decrease in perceived pain and disability, improvement in function, and prevention of further work disability in one randomized trial of 103 workers with rotator cuff injuries.[234] After a four-week program, the work-place group achieved a 71% return to work rate compared to 37% the generic off-site group. Employers who utilized a job coach may help minimize psychosocial problems that interfere with return to work (e.g. separation from work, peer group and/or the employer) • Multidisciplinary rehab is effective for lower extremity joint replacement and amputation, but studies on less severe LE musculoskeletal injures are lacking.[235]
Return-to-Work Assistance	Workers' compensation patients have higher rates of subsequent pain or injury than non-workers' compensation patients and may require additional assistance.[236, 237] Knowledgeable clinicians can help smooth the RTW process.[238, 239] Median times to return to work tend to be longer for workers' compensation patients and striving for faster reintegration is beneficial.[237] Most patients (60-80%) are able to return to work with appropriate functional capacity evaluations even after significant orthopedic injury, however the time to RTW was 6mo-1yr and some were still not recovered at 2 years.[240-242]
Personal Controls Ergonomics Training, Braces, Biofeedback, On-the-job Exercise Programs	Prevention of LE MSK disorders: Physical training and footwear modification did not reduce musculoskeletal injuries or stress fractures.[243] There is only weak evidence to support any interventions that might prevent lower extremity injuries. Cost and benefit must be assessed.
Workflow/task Modifications	Activity pacing may be helpful for more serious lower extremity musculoskeletal disorders, such as fractures or amputations or chronic recurrent conditions like osteoarthritis and pain.[235] Symptom management and cognitive behavioral strategies may be a useful clinical strategy, but evidence is limited.[244]
Documentation of Progress	Function questionnaires such as FAAM or SEFAS should be used to establish a baseline functional level and re-administered at 2-4 week intervals to assess improvement. Customized outcome measures for unique tasks and individualized recovery tracking can be very helpful in documenting progress.[245] Consider the Patient-Specific Functional Scale (PSFS) for demonstrating graded progress on important tasks.[246]

Occupational Foot and Ankle Terminology

Exercise Approaches

General mobility – Early mobilization involves maintaining movement and weight bearing within tolerance, during initial phases of recovery. Principally, active movement and normal weight bearing are incrementally included for most ankle conditions (excluding some fractures and severe sprains which require a period of immobilization).

Neuromuscular (Balance, Proprioception, Coordination, and Gait) Training – Numerous approaches exist for neuromuscular training usually aimed at increasing responsiveness and coordination of lower leg and postural musculature. Examples include wobble boards, standing on one leg, to more sophisticated training and loading.

Stretching – Directed at reducing muscle tightness that may affect irritation of structures (e.g. tendon insertions) or biomechanics of foot and ankle movement. Intrinsic foot and lower leg muscular are typically targeted for stretch which is usually self-administered.

Strengthening – Aimed at improving both fiber recruitment and building muscular capacity, a number of various exercise regimens have been promulgated.

- Concentric loading involves active contraction of a muscle against a load. Rising up on one's toes would involve concentric contraction of calf muscles (the "up" or contraction phase of the movement).
- Eccentric loading is usually less demanding in terms of forces on muscles and involves lowering a load back to a starting position. Examples include: Standing on ones toes on a stair step and slowly lowering heels below the step.

Exercise Types

Active – Any active movement of a muscle or muscle group by the patient. Examples include box squats for kinetic chain strengthening with foot and ankle injuries, resistance weight training, or muscle energy techniques performed with a healthcare provider.

Passive– Provider-directed movement of the patient while the patient is relaxed. Some examples of passive therapies could include passive, static stretching performed by a healthcare provider or ballistic, passive stretching performed by a healthcare provider.

Static – Activities where a single position is maintained throughout. Examples of static activities include the classic runners stretch for the gastroc-soleus complex and foot intrinsic isometric strengthening exercises (e.g., Andreo Spino program).

Dynamic – Involves movement of a muscle or muscle group, typically through its full range of motion when possible. Repetitive calf raises and repetitive end-range stretching of the Achilles through a heel drop off of a step without holding the stretch are examples

Open-chain – Movements performed in a non-weight bearing position for the extremity being exercised. "A, B, C's" traced with foot movements in the seated position for post-acute ankle sprains and tubing exercises of the foot while seated are examples.

Closed-chain – Closed-chain movements of the foot and ankle are movements performed in a weight bearing position for the extremity being exercised. Single leg stands, with or without a rocker or wobble-board, box squats, and single leg "pistol" squats are closed-chain exercises.

Perturbation – The action of challenging a statically held position with the intention of retraining proprioceptive capacity. Perturbation can be achieved as simply as tapping a patient's shoulder while they are holding a single leg stand or as challengingly as

Imaging Indications:

Ottawa Ankle Rules – Bone tenderness at the posterior region of the medial or lateral malleolus; inability to bear weight on the injured foot.

Bernese Ankle Rules – Pain with indirect fibular stress; medial malleolar stress; compression stress of the mid and hind foot.

Types of orthoses

Braces and supports – such as an air cast, boot, or device independently attached to the lower extremity utilized as a temporary measure;

Corrective footwear – specially made shoes to be used on a long term or permanent basis;

Shoe inserts – which may be soft, semi-rigid, rigid, or heel-lifts directed at modifying how biomechanical stresses are directed during weight bearing –standing, walking, and running- usually on a long-term basis

Soft Tissue Techniques

Manual deep tissue release – Passive pressure to muscles to stimulate relaxation; typically on palpably taut/tender regions, or 'trigger points' which elicit an involuntary twitch response. Examples include trigger point pressure, pressure point therapy.

Instrument assisted deep tissue release – Typically incorporate blunt, contoured ceramic or metal instruments that may assist application of effleurage-like pressure or stimulation at muscle-tendon junctions. Examples include Nimmo, Functional Kinetic Treatment with Rehab (FKTR), Graston, Gua Sha.

Reflex relaxation techniques – Manual stimulation of muscles, fascia, and tendons aimed at stimulating proprioceptive rich structures or processes that mediate muscle relaxation. Examples include cross fiber friction (e.g., Cyriax, Barnes), muscle energy (contract – relax), active release technique (ART).

Additional Resources

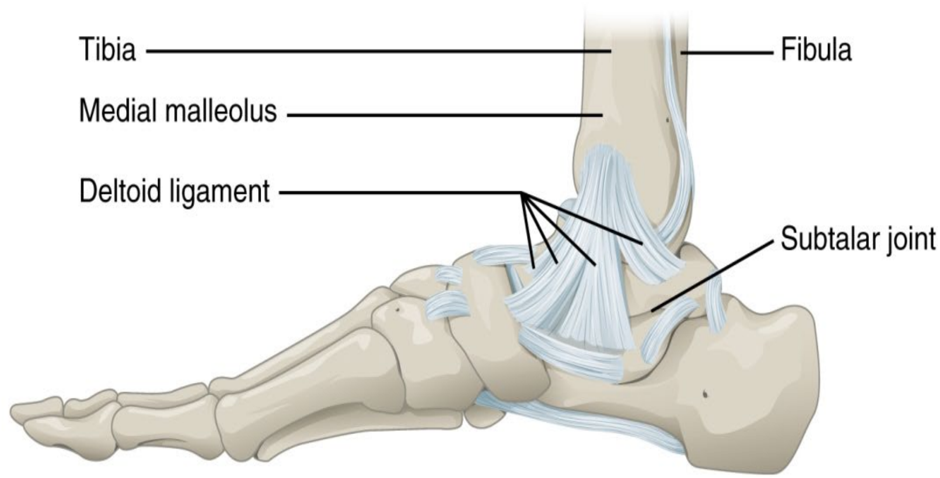
Hegman KT. (ed). ACOEM's Occupational Medicine Practice Guidelines, 3rd Edition, Volume 4 Lower Extremity Disorders.2011 American College of Occupational and Environmental Medicine, Elk Grove, IL. www.acoem.org

Michaud TC. Human Locomotion – The Conservative Management of Gait-Related Disorders. 2011 Newton Biomechanics, Newton, MA.

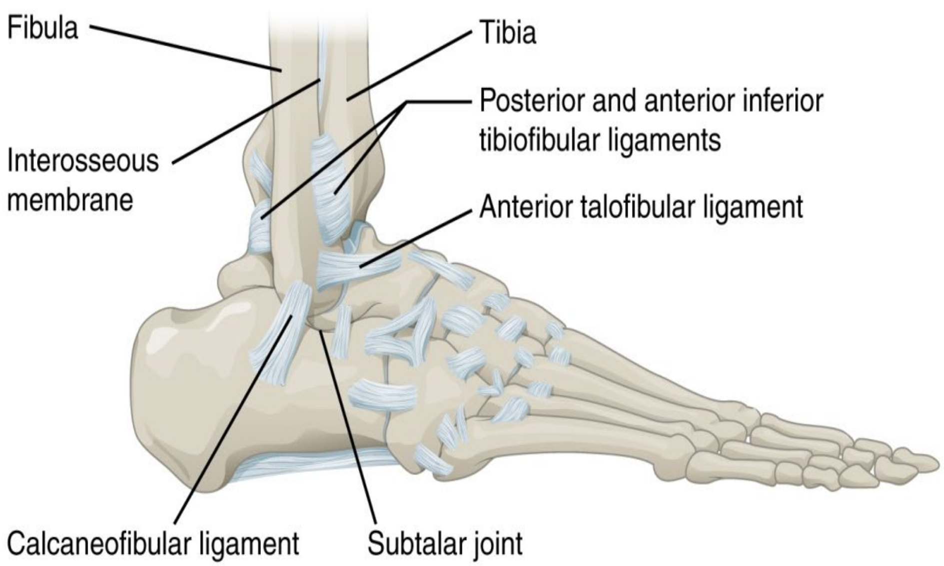
Souza TA. Differential Diagnosis and Management for the Chiropractor – Protocols and Algorithms. 2016 Jones and Bartlett Publishers, Sudbury, MA.

having them catch a medicine ball while maintaining a single leg stand during rehabilitation.	

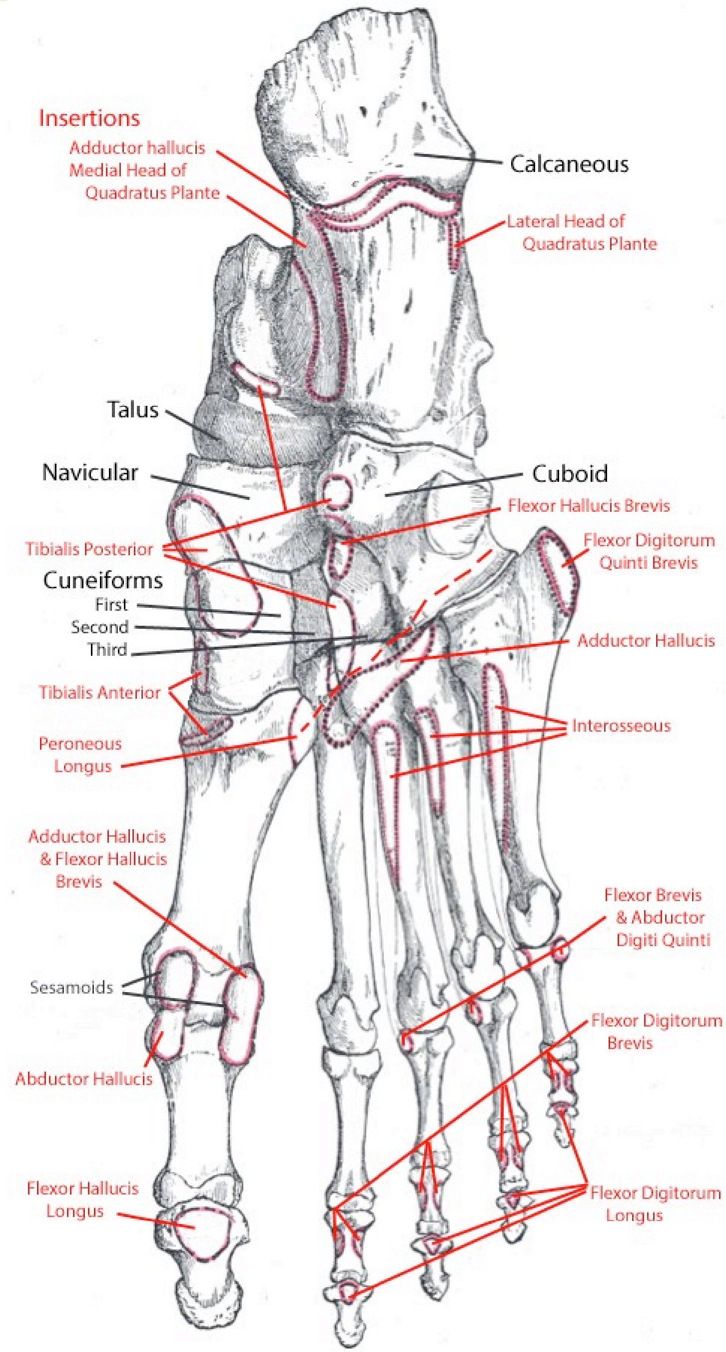
Foot and Ankle Anatomy



Medial view



Lateral view



Evidence & Methodology

Intervention/Experimental Studies

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

Observational Studies

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

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

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

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

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

Blinding

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

Literature Reviews

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

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

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

Literature Retrieval and Review

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

About Evidence for Physical Examination and Conservative Interventions

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

Assessing Study Methodologic Quality

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

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

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

Synthesizing Evidence

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

Citations

1. Souza, T.A., *Differential Diagnosis and Management for the Chiropractor: Protocols and Algorithms*. 5th ed. 2016: Jones and Bartlett Publishers: Sudbury, MA.
2. Young, C.C., et al., *Clinical examination of the foot and ankle.* Prim Care, 2005. **32**(1): p. 105-32.
3. Michaud, T., *The Conservative Management of Gait-Related Disorders*. 2011, Newton MA: Newton Biomechanics.
4. Delco, M.L., et al., *Post-traumatic osteoarthritis of the ankle: A distinct clinical entity requiring new research approaches.* J Orthop Res, 2017. **35**(3): p. 440-453.
5. *ACOEM's Occupational Medicine Practice Guidelines* 3rd ed. Vol. 4. 2011, Elk Grove, IL: American College of Occupational and Environmental Medicine.
6. Maffulli, N., *The clinical diagnosis of subcutaneous tear of the Achilles tendon. A prospective study in 174 patients.* Am J Sports Med, 1998. **26**(2): p. 266-70.
7. Coster, M., et al., *Validity, reliability, and responsiveness of a self-reported foot and ankle score (SEFAS).* Acta Orthop, 2012. **83**(2): p. 197-203.
8. Coster, M.C., et al., *Comparison of the Self-reported Foot and Ankle Score (SEFAS) and the American Orthopedic Foot and Ankle Society Score (AOFAS).* Foot Ankle Int, 2014. **35**(10): p. 1031-6.
9. Eechaute, C., et al., *The clinimetric qualities of patient-assessed instruments for measuring chronic ankle instability: a systematic review.* BMC Musculoskelet Disord, 2007. **8**: p. 6.
10. Martin, R.L. and J.J. Irrgang, *A survey of self-reported outcome instruments for the foot and ankle.* J Orthop Sports Phys Ther, 2007. **37**(2): p. 72-84.
11. Martin, R.L., et al., *Evidence of validity for the Foot and Ankle Ability Measure (FAAM).* Foot Ankle Int, 2005. **26**(11): p. 968-83.
12. Hale, S.A. and J. Hertel, *Reliability and Sensitivity of the Foot and Ankle Disability Index in Subjects With Chronic Ankle Instability.* J Athl Train, 2005. **40**(1): p. 35-40.
13. Budiman-Mak, E., K.J. Conrad, and K.E. Roach, *The Foot Function Index: a measure of foot pain and disability.* J Clin Epidemiol, 1991. **44**(6): p. 561-70.
14. Robinson, J.M., et al., *The VISA-A questionnaire: a valid and reliable index of the clinical severity of Achilles tendinopathy.* Br J Sports Med, 2001. **35**(5): p. 335-41.
15. Iversen, J.V., E.M. Bartels, and H. Langberg, *The victorian institute of sports assessment - achilles questionnaire (visa-a) - a reliable tool for measuring achilles tendinopathy.* Int J Sports Phys Ther, 2012. **7**(1): p. 76-84.
16. Hosman, A.H., et al., *A New Zealand national joint registry review of 202 total ankle replacements followed for up to 6 years.* Acta Orthop, 2007. **78**(5): p. 584-91.
17. Lau, J.T., N.M. Mahomed, and L.C. Schon, *Results of an Internet survey determining the most frequently used ankle scores by AOFAS members.* Foot Ankle Int, 2005. **26**(6): p. 479-82.
18. Ibrahim, T., et al., *Reliability and validity of the subjective component of the American Orthopaedic Foot and Ankle Society clinical rating scales.* J Foot Ankle Surg, 2007. **46**(2): p. 65-74.
19. Roos, E.M., S. Brandsson, and J. Karlsson, *Validation of the foot and ankle outcome score for ankle ligament reconstruction.* Foot Ankle Int, 2001. **22**(10): p. 788-94.
20. Hiller, C.E., et al., *The Cumberland ankle instability tool: a report of validity and reliability testing.* Arch Phys Med Rehabil, 2006. **87**(9): p. 1235-41.
21. Wright, C.J., et al., *Recalibration and validation of the Cumberland Ankle Instability Tool cutoff score for individuals with chronic ankle instability.* Arch Phys Med Rehabil, 2014. **95**(10): p. 1853-9.
22. Pourkazemi, F., et al., *Predictors of chronic ankle instability after an index lateral ankle sprain: a systematic review.* J Sci Med Sport, 2014. **17**(6): p. 568-73.
23. Turner, J.A., et al., *Back pain in primary care. Patient characteristics, content of initial visit, and short-term outcomes.* Spine (Phila Pa 1976), 1998. **23**(4): p. 463-9.
24. Von Korff, M., et al., *Comparison of back pain prognostic risk stratification item sets.* J Pain, 2014. **15**(1): p. 81-9.

25. Croy, T., et al., *Anterior talocrural joint laxity: diagnostic accuracy of the anterior drawer test of the ankle.* J Orthop Sports Phys Ther, 2013. **43**(12): p. 911-9.
26. Lee, K.T., et al., *New method of diagnosis for chronic ankle instability: comparison of manual anterior drawer test, stress radiography and stress ultrasound.* Knee Surg Sports Traumatol Arthrosc, 2014. **22**(7): p. 1701-7.
27. Vaseenon, T., Y. Gao, and P. Phisitkul, *Comparison of two manual tests for ankle laxity due to rupture of the lateral ankle ligaments.* Iowa Orthop J, 2012. **32**: p. 9-16.
28. Rosen, A.B., J. Ko, and C.N. Brown, *Diagnostic accuracy of instrumented and manual talar tilt tests in chronic ankle instability populations.* Scand J Med Sci Sports, 2014.
29. Sman, A.D., et al., *Diagnostic accuracy of clinical tests for ankle syndesmosis injury.* Br J Sports Med, 2013.
30. Sekir, U., et al., *Reliability of a functional test battery evaluating functionality, proprioception, and strength in recreational athletes with functional ankle instability.* Eur J Phys Rehabil Med, 2008. **44**(4): p. 407-15.
31. *Occupational Medicine Practice Guidelines* 3rd ed, ed. K. Hegmann. Vol. 4. 2011, Elk Grove, IL: American College of Occupational and Environmental Medicine.
32. Bussieres, A.E., J.A. Taylor, and C. Peterson, *Diagnostic imaging practice guidelines for musculoskeletal complaints in adults--an evidence-based approach. Part 1. Lower extremity disorders.* J Manipulative Physiol Ther, 2007. **30**(9): p. 684-717.
33. Gomes, Y.E., et al., *Diagnostic accuracy of the Ottawa ankle rule to exclude fractures in acute ankle injuries in adults: a systematic review and meta-analysis.* BMC Musculoskelet Disord, 2022. **23**(1): p. 885.
34. Eggli, S., et al., *The Bernese ankle rules: a fast, reliable test after low-energy, supination-type malleolar and midfoot trauma.* J Trauma, 2005. **59**(5): p. 1268-71.
35. Bachmann, L.M., et al., *Accuracy of Ottawa ankle rules to exclude fractures of the ankle and mid-foot: systematic review.* BMJ, 2003. **326**(7386): p. 417.
36. Chun, D.I., et al., *Diagnostic Accuracy of Radiologic Methods for Ankle Syndesmosis Injury: A Systematic Review and Meta-Analysis.* J Clin Med, 2019. **8**(7).
37. Garras, D.N., et al., *MRI is unnecessary for diagnosing acute Achilles tendon ruptures: clinical diagnostic criteria.* Clin Orthop Relat Res, 2012. **470**(8): p. 2268-73.
38. Magnussen, R.A., W.R. Dunn, and A.B. Thomson, *Nonoperative treatment of midportion Achilles tendinopathy: a systematic review.* Clin J Sport Med, 2009. **19**(1): p. 54-64.
39. van Dijk, C.N., et al., *Terminology for Achilles tendon related disorders.* Knee Surg Sports Traumatol Arthrosc, 2011. **19**(5): p. 835-41.
40. Wiegerinck, J.I., et al., *Treatment for insertional Achilles tendinopathy: a systematic review.* Knee Surg Sports Traumatol Arthrosc, 2013. **21**(6): p. 1345-55.
41. Bagley, C. and L. Parker, *Diagnosis and treatment of peroneal tendon disorders.* Orthopaedics and Trauma, 2023. **37**(1): p. 71-78.
42. Davda, K., et al., *Peroneal tendon disorders.* EFORT Open Rev, 2017. **2**(6): p. 281-292.
43. van Dijk, P.A., et al., *The ESSKA-AFAS international consensus statement on peroneal tendon pathologies.* Knee Surgery, Sports Traumatology, Arthroscopy, 2018. **26**(10): p. 3096-3107.
44. Janig, W. and R. Baron, *Complex regional pain syndrome: mystery explained?* Lancet Neurol, 2003. **2**(11): p. 687-97.
45. *Industrial Insurance Medical Advisory Committee (IIMAC). Work-Related Complex Regional Pain Syndrome (CRPS): Diagnosis and Treatment, 2011. State of Washington Department of Labor & Industries. Olympia WA*.
46. Coleman, M., et al., *Pes Cavus and Hindfoot Varus Alignment Are Associated with Increased Rates of Peroneal Tendon Pathology.* Foot Ankle Orthop, 2019. **4**(4).
47. Guyton, G.P., et al., *Cumulative industrial trauma as an etiology of seven common disorders in the foot and ankle: what is the evidence?* Foot Ankle Int, 2000. **21**(12): p. 1047-56.
48. Galasso, A., et al., *A Detailed Analysis of Workplace Foot and Ankle Injuries.* Foot & Ankle Specialist, 2024. **0**(0): p. 19386400241233844.

49. Melhorn JM, T.J., Ackerman WE, Hyman MH. , *AMA Guides to the Evaluation of Disease and Injury Causation*. 2nd ed. 2014: American Medical Association.
50. Milgrom, C., et al., *Cold weather training: a risk factor for Achilles paratendinitis among recruits.* Foot Ankle Int, 2003. **24**(5): p. 398-401.
51. Thomas, M.J., et al., *The population prevalence of foot and ankle pain in middle and old age: a systematic review.* Pain, 2011. **152**(12): p. 2870-80.
52. Veljkovic, A., et al., *Factors Associated with Return to Work Following Work-Related Injuries to the Lower Extremities.* Adv Res Foot Ankle: ARFA-108. DOI, 2018. **10**.
53. Rhon, D.I., et al., *Delayed rehabilitation is associated with recurrence and higher medical care use after ankle sprain injuries in the United States military health system.* journal of orthopaedic & sports physical therapy, 2021. **51**(12): p. 619-627.
54. van Middelkoop, M., et al., *Re-sprains during the first 3 months after initial ankle sprain are related to incomplete recovery: an observational study.* J Physiother, 2012. **58**(3): p. 181-8.
55. Wagemans, J., et al., *Exercise-based rehabilitation reduces reinjury following acute lateral ankle sprain: A systematic review update with meta-analysis.* PLoS One, 2022. **17**(2): p. e0262023.
56. Maria, P.A., G. Vuurberg, and G.M. Kerkhoffs, *Exploring influences and risk of bias of studies on return to sport and work after lateral ankle sprain: A systematic review and meta-analysis.* World Journal of Meta-Analysis, 2024. **12**(1).
57. Fu, S.C., et al., *Deciphering the pathogenesis of tendinopathy: a three-stages process.* Sports Med Arthrosc Rehabil Ther Technol, 2010. **2**: p. 30.
58. Murtaugh, B. and J.M. Ihm, *Eccentric training for the treatment of tendinopathies.* Curr Sports Med Rep, 2013. **12**(3): p. 175-82.
59. Knobloch, K., *Re: Acute Achilles tendon rupture: minimally invasive surgery versus nonoperative treatment with immediate full weightbearing.* Am J Sports Med, 2008. **36**(12): p. E3-4; author reply E4.
60. Knobloch, K., H. Thermann, and T. Hufner, *[Achilles tendon rupture--early functional and surgical options with special emphasis on rehabilitation issues].* Sportverletz Sportschaden, 2007. **21**(1): p. 34-40.
61. Brinks, A., et al., *Adverse effects of extra-articular corticosteroid injections: a systematic review.* BMC Musculoskelet Disord, 2010. **11**: p. 206.
62. Wiegerinck, J.I., A.C. Kok, and C.N. van Dijk, *Surgical treatment of chronic retrocalcaneal bursitis.* Arthroscopy, 2012. **28**(2): p. 283-93.
63. Dold, A.P., *Acute Achilles Tendon Ruptures: An Update on Current Management Strategies.* JAAOS-Journal of the American Academy of Orthopaedic Surgeons, 2022: p. 10.5435.
64. Holm, C., M. Kjaer, and P. Eliasson, *Achilles tendon rupture - treatment and complications: A systematic review.* Scand J Med Sci Sports, 2015. **25**(1): p. e1-e10.
65. Deng, S., et al., *Surgical treatment versus conservative management for acute Achilles tendon rupture: a systematic review and meta-analysis of randomized controlled trials.* The Journal of Foot and Ankle Surgery, 2017. **56**(6): p. 1236-1243.
66. Metz, R., et al., *Acute Achilles tendon rupture: minimally invasive surgery versus nonoperative treatment with immediate full weightbearing--a randomized controlled trial.* Am J Sports Med, 2008. **36**(9): p. 1688-94.
67. Saleh, M., et al., *The Sheffield splint for controlled early mobilisation after rupture of the calcaneal tendon. A prospective, randomised comparison with plaster treatment.* J Bone Joint Surg Br, 1992. **74**(2): p. 206-9.
68. van der Linden-van der Zwaag, H.M., R.G. Nelissen, and J.B. Sintenie, *Results of surgical versus non-surgical treatment of Achilles tendon rupture.* Int Orthop, 2004. **28**(6): p. 370-3.
69. Myhrvold, S.B., et al., *Nonoperative or surgical treatment of acute Achilles' tendon rupture.* New England Journal of Medicine, 2022. **386**(15): p. 1409-1420.
70. Amendola, F., et al., *The acute Achilles tendon rupture: An evidence-based approach from the diagnosis to the treatment.* Medicina, 2022. **58**(9): p. 1195.
71. Mattila, V.M., et al., *Declining incidence of surgery for Achilles tendon rupture follows publication of major RCTs: evidence-influenced change evident using the Finnish registry study.* Br J Sports Med, 2013.
72. Lugo-Pico, J.G., et al., *Peroneal Tendinosis and Subluxation.* Clin Sports Med, 2020. **39**(4): p. 845-858.
73. Howard, A., A. John, and R. Theiss, *Peroneus Tendon Disorders: Evaluation and Non-operative Management.* Current Physical Medicine and Rehabilitation Reports, 2023. **11**: p. 1-11.

74. Cushman, D.M., et al., *A Systematic Review of the Efficacy of Corticosteroid Injections of Tendon Sheaths, Excluding Stenosing Tenosynovitis of the Wrist and Hand.* Am J Phys Med Rehabil, 2021. **100**(7): p. 683-688.
75. Thomas, J.L., et al., *The diagnosis and treatment of heel pain: a clinical practice guideline-revision 2010.* J Foot Ankle Surg, 2010. **49**(3 Suppl): p. S1-19.
76. Goff, J.D. and R. Crawford, *Diagnosis and treatment of plantar fasciitis.* Am Fam Physician, 2011. **84**(6): p. 676-82.
77. Schepsis, A.A., R.E. Leach, and J. Gorzyca, *Plantar fasciitis. Etiology, treatment, surgical results, and review of the literature.* Clin Orthop Relat Res, 1991(266): p. 185-96.
78. Morrissey, D., et al., *Management of plantar heel pain: a best practice guide informed by a systematic review, expert clinical reasoning and patient values.* Br J Sports Med, 2021. **55**(19): p. 1106-1118.
79. Li, X., et al., *Comparative effectiveness of extracorporeal shock wave, ultrasound, low-level laser therapy, noninvasive interactive neurostimulation, and pulsed radiofrequency treatment for treating plantar fasciitis: A systematic review and network meta-analysis.* Medicine (Baltimore), 2018. **97**(43): p. e12819.
80. Schuitema, D., et al., *Effectiveness of Mechanical Treatment for Plantar Fasciitis: A Systematic Review.* J Sport Rehabil, 2020. **29**(5): p. 657-674.
81. Fortier, L.M., et al., *An update on posterior tarsal tunnel syndrome.* Orthopedic reviews, 2022. **14**(3): p. 35444.
82. Rodríguez-Merchán, E.C. and I. Moracia-Ochagavía, *Tarsal tunnel syndrome: current rationale, indications and results.* EFORT open reviews, 2021. **6**(12): p. 1140-1147.
83. Madani, S. and C. Doughty, *Lower extremity entrapment neuropathies.* Best Practice & Research Clinical Rheumatology, 2020. **34**(3): p. 101565.
84. Kavlak, Y. and F. Uygur, *Effects of nerve mobilization exercise as an adjunct to the conservative treatment for patients with tarsal tunnel syndrome.* J Manipulative Physiol Ther, 2011. **34**(7): p. 441-8.
85. Mackinnon, S.E., et al., *Peripheral nerve injection injury with steroid agents.* Plast Reconstr Surg, 1982. **69**(3): p. 482-90.
86. Vij, N., et al., *Clinical results following conservative management of tarsal tunnel syndrome compared with surgical treatment: a systematic review.* Orthopedic Reviews, 2022. **14**(3): p. 37539.
87. Gkotsoulias, E.N., D.C. Simonson, and T.S. Roukis, *Outcomes and safety of endoscopic tarsal tunnel decompression: a systematic review.* Foot Ankle Spec, 2014. **7**(1): p. 57-60.
88. Batt, J. and M.M. Neeki, *Osteopathic manipulative treatment in tarsal somatic dysfunction: a case study.* J Am Osteopath Assoc, 2013. **113**(11): p. 857-61.
89. Menetrey, J. and D. Fritschy, *Subtalar subluxation in ballet dancers.* Am J Sports Med, 1999. **27**(2): p. 143-9.
90. Mooney, M. and L. Maffey-Ward, *Cuboid plantar and dorsal subluxations: assessment and treatment.* J Orthop Sports Phys Ther, 1994. **20**(4): p. 220-6.
91. Patterson, S.M., *Cuboid syndrome: a review of the literature.* J Sports Sci Med, 2006. **5**(4): p. 597-606.
92. Brantingham, J.W., et al., *Manipulative therapy for lower extremity conditions: update of a literature review.* J Manipulative Physiol Ther, 2012. **35**(2): p. 127-66.
93. Dilnot, M. and T.C. Michaud, *Plantar plate rupture.* Australasian Journal of Podiatric Medicine, 2003. **37**(2): p. 43-46.
94. Nwawka, O.K., et al., *Sesamoids and accessory ossicles of the foot: anatomical variability and related pathology.* Insights Imaging, 2013. **4**(5): p. 581-93.
95. Herterich, V., et al., *Fifth metatarsal fracture: a systematic review of the treatment of fractures of the base of the fifth metatarsal bones.* Deutsches Ärzteblatt International, 2021. **118**(35-36): p. 587.
96. Dean, B.J., et al., *The jones fracture classification, management, outcome, and complications: a systematic review.* Foot Ankle Spec, 2012. **5**(4): p. 256-9.
97. Polzer, H., et al., *Acute fractures to the proximal fifth metatarsal bone: development of classification and treatment recommendations based on the current evidence.* Injury, 2012. **43**(10): p. 1626-32.
98. Kim, J.Y., et al., *An anatomical study of Morton's interdigital neuroma: the relationship between the occurring site and the deep transverse metatarsal ligament (DTML).* Foot Ankle Int, 2007. **28**(9): p. 1007-10.
99. Matthews, B.G., et al., *The effectiveness of non-surgical interventions for common plantar digital compressive neuropathy (Morton's neuroma): A systematic review and meta-analysis.* Journal of foot and ankle research, 2019. **12**(1): p. 12.
100. Thomson, L., et al., *Non-surgical treatments for Morton's neuroma: a systematic review.* Foot and Ankle Surgery, 2020. **26**(7): p. 736-743.

101. Matthews, B.G., et al., *Treatments for Morton's neuroma.* The Cochrane database of systematic reviews, 2024. **2**(2): p. CD014687.
102. Millán-Silva, M.O., P.V. Munuera-Martínez, and P. Távara-Vidalón, *Infiltrative Treatment of Morton's Neuroma: A Systematic Review.* Pain Management Nursing, 2024.
103. Valisena, S., G.J. Petri, and A. Ferrero, *Treatment of Morton’s neuroma: a systematic review.* Foot and Ankle Surgery, 2018. **24**(4): p. 271-281.
104. Shibuya N, H.J., Agarwal MR, Jupiter DC., *Efficacy and safety of high-dose vitamin C on complex regional pain syndrome in extremity trauma and surgery--systematic review and meta-analysis.* J Foot Ankle Surg, 2013. **52**(1): p. 62-66.
105. Bleakley, C.M., S.M. McDonough, and D.C. MacAuley, *Some conservative strategies are effective when added to controlled mobilisation with external support after acute ankle sprain: a systematic review.* Aust J Physiother, 2008. **54**(1): p. 7-20.
106. Black JD, B.M., Al-Hadithy N, Hakmi A, Kitson J., *Early weight-bearing in operatively fixed ankle fractures: a systematic review.* Foot (Edinb), 2013. **23**(2-3): p. 78-85.
107. Dettori, J.R. and C.J. Basmania, *Early ankle mobilization, Part II: A one-year follow-up of acute, lateral ankle sprains (a randomized clinical trial).* Mil Med, 1994. **159**(1): p. 20-4.
108. Dettori, J.R., et al., *Early ankle mobilization, Part I: The immediate effect on acute, lateral ankle sprains (a randomized clinical trial).* Mil Med, 1994. **159**(1): p. 15-20.
109. Eiff, M.P., A.T. Smith, and G.E. Smith, *Early mobilization versus immobilization in the treatment of lateral ankle sprains.* Am J Sports Med, 1994. **22**(1): p. 83-8.
110. Karlsson, J., et al., *Early mobilization versus immobilization after ankle ligament stabilization.* Scand J Med Sci Sports, 1999. **9**(5): p. 299-303.
111. van Ochten, J.M., et al., *Chronic complaints after ankle sprains: a systematic review on effectiveness of treatments.* J Orthop Sports Phys Ther, 2014. **44**(11): p. 862-C23.
112. Kaikkonen, A., P. Kannus, and M. Jarvinen, *Surgery versus functional treatment in ankle ligament tears. A prospective study.* Clin Orthop Relat Res, 1996(326): p. 194-202.
113. Lehtonen, H., et al., *Use of a cast compared with a functional ankle brace after operative treatment of an ankle fracture. A prospective, randomized study.* J Bone Joint Surg Am, 2003. **85-A**(2): p. 205-11.
114. Loudon, J.K., M.P. Reiman, and J. Sylvain, *The efficacy of manual joint mobilisation/manipulation in treatment of lateral ankle sprains: a systematic review.* Br J Sports Med, 2014. **48**(5): p. 365-70.
115. Vicenzino, B., et al., *Initial changes in posterior talar glide and dorsiflexion of the ankle after mobilization with movement in individuals with recurrent ankle sprain.* J Orthop Sports Phys Ther, 2006. **36**(7): p. 464-71.
116. Collins, N., P. Teys, and B. Vicenzino, *The initial effects of a Mulligan's mobilization with movement technique on dorsiflexion and pain in subacute ankle sprains.* Man Ther, 2004. **9**(2): p. 77-82.
117. Eisenhart, A.W., T.J. Gaeta, and D.P. Yens, *Osteopathic manipulative treatment in the emergency department for patients with acute ankle injuries.* J Am Osteopath Assoc, 2003. **103**(9): p. 417-21.
118. Grindstaff, T.L., et al., *Immediate effects of a tibiofibular joint manipulation on lower extremity H-reflex measurements in individuals with chronic ankle instability.* J Electromyogr Kinesiol, 2011. **21**(4): p. 652-8.
119. Beazell, J.R., et al., *Effects of a proximal or distal tibiofibular joint manipulation on ankle range of motion and functional outcomes in individuals with chronic ankle instability.* J Orthop Sports Phys Ther, 2012. **42**(2): p. 125-34.
120. Andersen, S., G.A. Fryer, and P. McLaughlin, *The effect of talo-crural joint manipulation on range of motion at the ankle joint in subjects with a history of ankle injury.* Australas Chiropr Osteopathy, 2003. **11**(2): p. 57-62.
121. Marron-Gomez, D., A.L. Rodriguez-Fernandez, and J.A. Martin-Urrialde, *The effect of two mobilization techniques on dorsiflexion in people with chronic ankle instability.* Phys Ther Sport, 2015. **16**(1): p. 10-5.
122. Pellow, J.E. and J.W. Brantingham, *The efficacy of adjusting the ankle in the treatment of subacute and chronic grade I and grade II ankle inversion sprains.* J Manipulative Physiol Ther, 2001. **24**(1): p. 17-24.

123. van der Wees, P.J., et al., *Effectiveness of exercise therapy and manual mobilisation in ankle sprain and functional instability: a systematic review.* Aust J Physiother, 2006. **52**(1): p. 27-37.
124. Green, T., et al., *A randomized controlled trial of a passive accessory joint mobilization on acute ankle inversion sprains.* Phys Ther, 2001. **81**(4): p. 984-94.
125. Cleland, J.A., et al., *Manual physical therapy and exercise versus supervised home exercise in the management of patients with inversion ankle sprain: a multicenter randomized clinical trial.* J Orthop Sports Phys Ther, 2013. **43**(7): p. 443-55.
126. Lubbe, D., et al., *Manipulative therapy and rehabilitation for recurrent ankle sprain with functional instability: a short-term, assessor-blind, parallel-group randomized trial.* J Manipulative Physiol Ther, 2015. **38**(1): p. 22-34.
127. Cruz-Diaz, D., et al., *Effects of joint mobilization on chronic ankle instability: a randomized controlled trial.* Disabil Rehabil, 2014: p. 1-10.
128. Truyols-Dominguez, S., et al., *Efficacy of thrust and nonthrust manipulation and exercise with or without the addition of myofascial therapy for the management of acute inversion ankle sprain: a randomized clinical trial.* J Orthop Sports Phys Ther, 2013. **43**(5): p. 300-9.
129. Whitman, J.M., et al., *Predicting short-term response to thrust and nonthrust manipulation and exercise in patients post inversion ankle sprain.* J Orthop Sports Phys Ther, 2009. **39**(3): p. 188-200.
130. Bisset, L., et al., *A systematic review and meta-analysis of clinical trials on physical interventions for lateral epicondylalgia.* Br J Sports Med, 2005. **39**(7): p. 411-22; discussion 411-22.
131. Muth, S., et al., *The effects of thoracic spine manipulation in subjects with signs of rotator cuff tendinopathy.* J Orthop Sports Phys Ther, 2012. **42**(12): p. 1005-16.
132. Cleland, J.A., et al., *Manual physical therapy and exercise versus electrophysical agents and exercise in the management of plantar heel pain: a multicenter randomized clinical trial.* J Orthop Sports Phys Ther, 2009. **39**(8): p. 573-85.
133. Dimou, E.S., J.W. Brantingham, and T. Wood, *A randomized controlled trial (with blinded observer) of chiropractic manipulation and Achilles stretching vs. orthotics for treatment of plantar fasciitis. .* J Am Chiropr Assoc 2004. **41**(9): p. 32-42.
134. McClinton, S.M., J.A. Cleland, and T.W. Flynn, *Predictors of Response to Physical Therapy Intervention for Plantar Heel Pain.* Foot Ankle Int, 2014.
135. Davis, P.T., et al., *Comparative efficacy of conservative medical and chiropractic treatments for carpal tunnel syndrome: a randomized clinical trail.* J Manipulative Physiol Ther, 1998. **21**(5): p. 317-26.
136. Burke, J., et al., *A pilot study comparing two manual therapy interventions for carpal tunnel syndrome.* J Manipulative Physiol Ther, 2007. **30**(1): p. 50-61.
137. Leblebicier, M.A., et al., *The effects of tibial nerve mobilization in patients with tarsal tunnel syndrome: A randomized controlled trial.* European Journal of Integrative Medicine, 2022. **56**: p. 102201.
138. Petersen, S., J. Brantingham, and H. Kretzmann, *The efficacy of chiropractic adjustment in the treatment of primary metatarsalgia.* Euro J Chiropr, 2003. **49**(3): p. 267-279.
139. Brantingham, J.W. and T.G. Wood, *Hallux rigidus.* J Chiropr Med, 2002. **1**(1): p. 31-7.
140. Manral, D.B., *Hallux rigidus: A case report of successful chiropractic management and review of the literature.* J Chiropr Med, 2004. **3**(1): p. 6-11.
141. Solan, M.C., J.D. Calder, and S.P. Bendall, *Manipulation and injection for hallux rigidus. Is it worthwhile?* J Bone Joint Surg Br, 2001. **83**(5): p. 706-8.
142. Brumm, L.F., et al., *Preventive osteopathic manipulative treatment and stress fracture incidence among collegiate cross-country athletes.* J Am Osteopath Assoc, 2013. **113**(12): p. 882-90.
143. Andres, B.M. and G.A. Murrell, *Treatment of tendinopathy: what works, what does not, and what is on the horizon.* Clin Orthop Relat Res, 2008. **466**(7): p. 1539-54.
144. Verhagen, E.A., *What does therapeutic ultrasound add to recovery from acute ankle sprain? A review.* Clin J Sport Med, 2013. **23**(1): p. 84-5.
145. Terada, M., B.G. Pietrosimone, and P.A. Gribble, *Therapeutic interventions for increasing ankle dorsiflexion after ankle sprain: a systematic review.* J Athl Train, 2013. **48**(5): p. 696-709.
146. Kaminski, T.W., et al., *National Athletic Trainers' Association position statement: conservative management and prevention of ankle sprains in athletes.* J Athl Train, 2013. **48**(4): p. 528-45.
147. Khan, K.M., et al., *Time to abandon the "tendinitis" myth.* BMJ, 2002. **324**(7338): p. 626-7.
148. Sussmilch-Leitch, S.P., et al., *Physical therapies for Achilles tendinopathy: systematic review and meta-analysis.* J Foot Ankle Res, 2012. **5**(1): p. 15.

149. Chapman-Jones D, H.D., *Novel microcurrent treatment is more effective than conventional therapy for chronic Achilles tendinopathy: randomised comparative trial.* Physiotherapy, 2002. **88**(8): p. 471-480.
150. Brummitt, J., *The role of massage in sports performance and rehabilitation: current evidence and future direction.* N Am J Sports Phys Ther, 2008. **3**(1): p. 7-21.
151. Wikstrom, E.A., et al., *Comparative Effectiveness of Plantar-Massage Techniques on Postural Control in Those With Chronic Ankle Instability.* J Athl Train, 2017. **52**(7): p. 629-635.
152. Renan-Ordine, R., et al., *Effectiveness of myofascial trigger point manual therapy combined with a self-stretching protocol for the management of plantar heel pain: a randomized controlled trial.* J Orthop Sports Phys Ther, 2011. **41**(2): p. 43-50.
153. Davis, F., *Therapeutic Massage Provides Pain Relief to a Client with Morton's Neuroma: A Case Report.* Int J Ther Massage Bodywork, 2012. **5**(2): p. 12-9.
154. Stevens, M. and C.-W. Tan, *Effectiveness of the Alfredson protocol compared with a lower repetition-volume protocol for midportion Achilles tendinopathy: a randomized controlled trial.* journal of orthopaedic & sports physical therapy, 2014. **44**(2): p. 59-67.
155. Abdel-Aziem, A.A. and W.S. Mohammad, *Plantar-flexor Static Stretch Training Effect on Eccentric and Concentric Peak Torque - A comparative Study of Trained versus Untrained Subjects.* J Hum Kinet, 2012. **34**: p. 49-58.
156. Avloniti, A., et al., *The Acute Effects of Static Stretching on Speed and Agility Performance Depend on Stretch Duration and Conditioning Level.* J Strength Cond Res, 2014.
157. van Rijn, R.M., et al., *Effectiveness of additional supervised exercises compared with conventional treatment alone in patients with acute lateral ankle sprains: systematic review.* BMJ, 2010. **341**: p. c5688.
158. van Os, A.G., et al., *Comparison of conventional treatment and supervised rehabilitation for treatment of acute lateral ankle sprains: a systematic review of the literature.* J Orthop Sports Phys Ther, 2005. **35**(2): p. 95-105.
159. Struijs, P.A. and G.M. Kerkhoffs, *Ankle sprain.* BMJ Clin Evid, 2010. **2010**.
160. Chaiwanichsiri, D., E. Lorprayoon, and L. Noomanoch, *Star excursion balance training: effects on ankle functional stability after ankle sprain.* J Med Assoc Thai, 2005. **88 Suppl 4**: p. S90-4.
161. Hupperets, M.D., E.A. Verhagen, and W. van Mechelen, *Effect of unsupervised home based proprioceptive training on recurrences of ankle sprain: randomised controlled trial.* BMJ, 2009. **339**: p. b2684.
162. Postle, K., D. Pak, and T.O. Smith, *Effectiveness of proprioceptive exercises for ankle ligament injury in adults: a systematic literature and meta-analysis.* Man Ther, 2012. **17**(4): p. 285-91.
163. Hubscher, M., et al., *Neuromuscular training for sports injury prevention: a systematic review.* Med Sci Sports Exerc, 2010. **42**(3): p. 413-21.
164. Zech, A., et al., *Neuromuscular training for rehabilitation of sports injuries: a systematic review.* Med Sci Sports Exerc, 2009. **41**(10): p. 1831-41.
165. Verhagen, E.A. and K. Bay, *Optimising ankle sprain prevention: a critical review and practical appraisal of the literature.* Br J Sports Med, 2010. **44**(15): p. 1082-8.
166. Hupperets, M.D., et al., *Potential savings of a program to prevent ankle sprain recurrence: economic evaluation of a randomized controlled trial.* Am J Sports Med, 2010. **38**(11): p. 2194-200.
167. Hupperets, M.D., E.A. Verhagen, and W. van Mechelen, *Effect of sensorimotor training on morphological, neurophysiological and functional characteristics of the ankle: a critical review.* Sports Med, 2009. **39**(7): p. 591-605.
168. McGuine, T.A. and J.S. Keene, *The effect of a balance training program on the risk of ankle sprains in high school athletes.* Am J Sports Med, 2006. **34**(7): p. 1103-11.
169. McHugh, M.P., et al., *The effectiveness of a balance training intervention in reducing the incidence of noncontact ankle sprains in high school football players.* Am J Sports Med, 2007. **35**(8): p. 1289-94.
170. McKeon, P.O. and J. Hertel, *Systematic review of postural control and lateral ankle instability, part II: is balance training clinically effective?* J Athl Train, 2008. **43**(3): p. 305-15.
171. Quigley, P.A., et al., *Exercise interventions, gait, and balance in older subjects with distal symmetric polyneuropathy: a three-group randomized clinical trial.* Am J Phys Med Rehabil, 2014. **93**(1): p. 1-12; quiz 13-6.

172. Mafi, N., R. Lorentzon, and H. Alfredson, *Superior short-term results with eccentric calf muscle training compared to concentric training in a randomized prospective multicenter study on patients with chronic Achilles tendinosis.* Knee Surg Sports Traumatol Arthrosc, 2001. **9**(1): p. 42-7.
173. Silbernagel, K.G., et al., *Continued sports activity, using a pain-monitoring model, during rehabilitation in patients with Achilles tendinopathy: a randomized controlled study.* Am J Sports Med, 2007. **35**(6): p. 897-906.
174. Wasielewski, N.J. and K.M. Kotsko, *Does eccentric exercise reduce pain and improve strength in physically active adults with symptomatic lower extremity tendinosis? A systematic review.* J Athl Train, 2007. **42**(3): p. 409-21.
175. Knobloch, K., et al., *Gender and eccentric training in Achilles mid-portion tendinopathy.* Knee Surg Sports Traumatol Arthrosc, 2010. **18**(5): p. 648-55.
176. Rompe, J.D., J. Furia, and N. Maffulli, *Eccentric loading versus eccentric loading plus shock-wave treatment for midportion achilles tendinopathy: a randomized controlled trial.* Am J Sports Med, 2009. **37**(3): p. 463-70.
177. Rompe, J.D., et al., *Eccentric loading, shock-wave treatment, or a wait-and-see policy for tendinopathy of the main body of tendo Achillis: a randomized controlled trial.* Am J Sports Med, 2007. **35**(3): p. 374-83.
178. Bek, N., et al., *Home-based general versus center-based selective rehabilitation in patients with posterior tibial tendon dysfunction.* Acta Orthop Traumatol Turc, 2012. **46**(4): p. 286-92.
179. Alvarez, R.G., et al., *Stage I and II posterior tibial tendon dysfunction treated by a structured nonoperative management protocol: an orthosis and exercise program.* Foot Ankle Int, 2006. **27**(1): p. 2-8.
180. Hensley, C.P. and A.J. Kavchak, *Novel use of a manual therapy technique and management of a patient with peroneal tendinopathy: a case report.* Man Ther, 2012. **17**(1): p. 84-8.
181. Herchenröder, M., D. Wilfling, and J. Steinhäuser, *Evidence for foot orthoses for adults with flatfoot: a systematic review.* J Foot Ankle Res, 2021. **14**(1): p. 57.
182. Boyce, S.H., M.A. Quigley, and S. Campbell, *Management of ankle sprains: a randomised controlled trial of the treatment of inversion injuries using an elastic support bandage or an Aircast ankle brace.* Br J Sports Med, 2005. **39**(2): p. 91-6.
183. Cooke, M.W., et al., *Treatment of severe ankle sprain: a pragmatic randomised controlled trial comparing the clinical effectiveness and cost-effectiveness of three types of mechanical ankle support with tubular bandage. The CAST trial.* Health Technol Assess, 2009. **13**(13): p. iii, ix-x, 1-121.
184. Lamb, S.E., et al., *Mechanical supports for acute, severe ankle sprain: a pragmatic, multicentre, randomised controlled trial.* Lancet, 2009. **373**(9663): p. 575-81.
185. Janssen, K.W., W. van Mechelen, and E.A. Verhagen, *Bracing superior to neuromuscular training for the prevention of self-reported recurrent ankle sprains: a three-arm randomised controlled trial.* Br J Sports Med, 2014. **48**(16): p. 1235-9.
186. Gabriner, M.L., et al., *The effectiveness of foot orthotics in improving postural control in individuals with chronic ankle instability: a critically appraised topic.* J Sport Rehabil, 2015. **24**(1): p. 68-71.
187. Terrier, P., F. Luthi, and O. Deriaz, *Do orthopaedic shoes improve local dynamic stability of gait? An observational study in patients with chronic foot and ankle injuries.* BMC Musculoskelet Disord, 2013. **14**: p. 94.
188. Mattila, V.M., et al., *Can orthotic insoles prevent lower limb overuse injuries? A randomized-controlled trial of 228 subjects.* Scand J Med Sci Sports, 2011. **21**(6): p. 804-8.
189. Petersen, W., R. Welp, and D. Rosenbaum, *Chronic Achilles tendinopathy: a prospective randomized study comparing the therapeutic effect of eccentric training, the AirHeel brace, and a combination of both.* Am J Sports Med, 2007. **35**(10): p. 1659-67.
190. Scott, L.A., S.E. Munteanu, and H.B. Menz, *Effectiveness of orthotic devices in the treatment of Achilles tendinopathy: a systematic review.* Sports Med, 2015. **45**(1): p. 95-110.
191. Kulig, K., et al., *Nonsurgical management of posterior tibial tendon dysfunction with orthoses and resistive exercise: a randomized controlled trial.* Phys Ther, 2009. **89**(1): p. 26-37.
192. Stuber, K. and K. Kristmanson, *Conservative therapy for plantar fasciitis: a narrative review of randomized controlled trials.* J Can Chiropr Assoc, 2006. **50**(2): p. 118-33.

193. Landorf, K.B., A.M. Keenan, and R.D. Herbert, *Effectiveness of foot orthoses to treat plantar fasciitis: a randomized trial.* Arch Intern Med, 2006. **166**(12): p. 1305-10.
194. Roos, E., M. Engstrom, and B. Soderberg, *Foot orthoses for the treatment of plantar fasciitis.* Foot Ankle Int, 2006. **27**(8): p. 606-11.
195. Pfeffer, G., et al., *Comparison of custom and prefabricated orthoses in the initial treatment of proximal plantar fasciitis.* Foot Ankle Int, 1999. **20**(4): p. 214-21.
196. McDonagh, M.S., et al., *Nonopioid pharmacologic treatments for chronic pain.* 2020.
197. Chuang, P.-Y., et al., *Do NSAIDs affect bone healing rate, delay union, or cause non-union: an updated systematic review and meta-analysis.* Frontiers in Endocrinology, 2024. **15**: p. 1428240.
198. Jones, P., et al., *Oral non-steroidal anti-inflammatory drugs versus other oral analgesic agents for acute soft tissue injury.* Cochrane Database of Systematic Reviews, 2015(7).
199. Murphy, P.B., et al., *Efficacy and safety of non-steroidal anti-inflammatory drugs (NSAIDs) for the treatment of acute pain after orthopedic trauma: a practice management guideline from the Eastern Association for the Surgery of Trauma and the Orthopedic Trauma Association.* Trauma Surgery & Acute Care Open, 2023. **8**(1).
200. Donley, B.G., et al., *The efficacy of oral nonsteroidal anti-inflammatory medication (NSAID) in the treatment of plantar fasciitis: a randomized, prospective, placebo-controlled study.* Foot Ankle Int, 2007. **28**(1): p. 20-3.
201. Hart, L., *Corticosteroid and other injections in the management of tendinopathies: a review. .* Clin J Sport Med. , 2011. **21**(6).
202. McMillan, A.M., et al., *Ultrasound guided corticosteroid injection for plantar fasciitis: randomised controlled trial.* BMJ, 2012. **344**: p. e3260.
203. Mulherin, D. and M. Price, *Efficacy of tibial nerve block, local steroid injection or both in the treatment of plantar heel pain syndrome.* Foot (Edinb), 2009. **19**(2): p. 98-100.
204. Gelberman, R.H., D. Aronson, and M.H. Weisman, *Carpal-tunnel syndrome. Results of a prospective trial of steroid injection and splinting.* J Bone Joint Surg Am, 1980. **62**(7): p. 1181-4.
205. Franklin, G.M., et al., *Early opioid prescription and subsequent disability among workers with back injuries: the Disability Risk Identification Study Cohort.* Spine (Phila Pa 1976), 2008. **33**(2): p. 199-204.
206. *Interagency Guideline on Opioid Dosing for Chronic Non-cancer Pain (2010). Agency Medical Directors Group. Oympia WA*.
207. Chou, R., et al., *Clinical guidelines for the use of chronic opioid therapy in chronic noncancer pain.* J Pain, 2009. **10**(2): p. 113-30.
208. Daniels, S.E. and M. Golf, *Clinical efficacy and safety of tapentadol immediate release in the postoperative setting.* J Am Podiatr Med Assoc, 2012. **102**(2): p. 139-48.
209. Kim, B.S., et al., *Comparison of multi-drug injection versus placebo after hallux valgus surgery.* Foot Ankle Int, 2011. **32**(9): p. 856-60.
210. Yadeau, J.T., et al., *Addition of pregabalin to multimodal analgesic therapy following ankle surgery: a randomized double-blind, placebo-controlled trial.* Reg Anesth Pain Med, 2012. **37**(3): p. 302-7.
211. Chou, R., et al., *Opioid treatments for chronic pain.* 2020.
212. Chou, R., et al., *Treatments for acute pain: a systematic review.* 2021.
213. Moraes, V.Y., et al., *Platelet-rich therapies for musculoskeletal soft tissue injuries.* Cochrane Database Syst Rev, 2014. **4**: p. CD010071.
214. de Vos, R.J., et al., *Platelet-rich plasma injection for chronic Achilles tendinopathy: a randomized controlled trial.* JAMA, 2010. **303**(2): p. 144-9.
215. Vannini, F., et al., *Platelet-rich plasma for foot and ankle pathologies: a systematic review.* Foot Ankle Surg, 2014. **20**(1): p. 2-9.
216. Chew, K.T., et al., *Comparison of autologous conditioned plasma injection, extracorporeal shockwave therapy, and conventional treatment for plantar fasciitis: a randomized trial.* PM R, 2013. **5**(12): p. 1035-43.
217. Monto, R.R., *Platelet-rich plasma efficacy versus corticosteroid injection treatment for chronic severe plantar fasciitis.* Foot Ankle Int, 2014. **35**(4): p. 313-8.
218. Martinelli, N., et al., *Platelet-rich plasma injections for chronic plantar fasciitis.* Int Orthop, 2013. **37**(5): p. 839-42.
219. Kumar, V., et al., *The treatment of intractable plantar fasciitis with platelet-rich plasma injection.* Foot (Edinb), 2013. **23**(2-3): p. 74-7.

220. Huang Z, C.J., Ma J, Shen B, Pei F, Kraus VB. , *Effectiveness of low-level laser therapy in patients with knee osteoarthritis: a systematic review and meta-analysis. .* Osteoarthritis Cartilage, 2015. **pii: S1063-4584**((15)): p. 01125-5.
221. Desmeules F, B.J., Roy JS, Dionne C, Frémont P, MacDermid JC. , *The efficacy of therapeutic ultrasound for rotator cuff tendinopathy: A systematic review and meta-analysis.* Phys Ther Sport, 2014. **pii: S1466-853X**((14)): p. 00077-7.
222. Izukura, H., et al., *Low Level Laser Therapy in patients with chronic foot and ankle joint pain.* Laser Ther, 2017. **26**(1): p. 19-24.
223. Naterstad, I.F., et al., *Efficacy of low-level laser therapy in patients with lower extremity tendinopathy or plantar fasciitis: systematic review and meta-analysis of randomised controlled trials.* BMJ Open, 2022. **12**(9): p. e059479.
224. Stergioulas, A., et al., *Effects of low-level laser therapy and eccentric exercises in the treatment of recreational athletes with chronic achilles tendinopathy.* Am J Sports Med, 2008. **36**(5): p. 881-7.
225. Kiritsi, O., et al., *Ultrasonographic evaluation of plantar fasciitis after low-level laser therapy: results of a double-blind, randomized, placebo-controlled trial.* Lasers Med Sci, 2010. **25**(2): p. 275-81.
226. Burton, I. and A. McCormack, *Blood Flow Restriction Resistance Training in Tendon Rehabilitation: A Scoping Review on Intervention Parameters, Physiological Effects, and Outcomes.* Front Sports Act Living, 2022. **4**: p. 879860.
227. Zhang, S.P., T.P. Yip, and Q.S. Li, *Acupuncture treatment for plantar fasciitis: a randomized controlled trial with six months follow-up.* Evid Based Complement Alternat Med, 2011. **2011**: p. 154108.
228. MacEachen, E., et al., *The "toxic dose" of system problems: why some injured workers don't return to work as expected.* J Occup Rehabil, 2010. **20**(3): p. 349-66.
229. Kunkel, M. and S.D. Miller, *Return to work after foot and ankle injury.* Foot Ankle Clin, 2002. **7**(2): p. 421-8, viii.
230. Collie, A., et al., *Does time off work after injury vary by jurisdiction? A comparative study of eight Australian workers' compensation systems.* BMJ Open, 2016. **6**(5): p. e010910.
231. Collie, A., et al., *Injured worker experiences of insurance claim processes and return to work: a national, cross-sectional study.* BMC Public Health, 2019. **19**(1): p. 927.
232. Gewurtz, R.E., S. Premji, and D.L. Holness, *The experiences of workers who do not successfully return to work following a work-related injury.* Work, 2018. **61**(4): p. 537-549.
233. Redfern MS, C.R., *The influence of flooring on standing comfort and fatigue.* AIHAJ, 2000. **61**(5): p. 700-708.
234. Cheng, A.S. and L.K. Hung, *Randomized controlled trial of workplace-based rehabilitation for work-related rotator cuff disorder.* J Occup Rehabil, 2007. **17**(3): p. 487-503.
235. Dorsey, J. and M. Bradshaw, *Effectiveness of occupational therapy interventions for lower-extremity musculoskeletal disorders: a systematic review.* The American Journal of Occupational Therapy, 2017. **71**(1): p. 7101180030p1-7101180030p11.
236. Bui, G., et al., *Subsequent pain or injury after foot and ankle surgery in patients receiving workers' compensation.* Foot & ankle international, 2020. **41**(1): p. 17-24.
237. Seland, K., N. Cherry, and J. Beach, *A study of factors influencing return to work after wrist or ankle fractures.* American journal of industrial medicine, 2006. **49**(3): p. 197-203.
238. Gelfman, R. and J.J. Hill, 3rd, *Rehabilitating the Injured/Ill Worker to Maximum Medical Improvement (MMI).* Phys Med Rehabil Clin N Am, 2019. **30**(3): p. 657-669.
239. Hammond, S., et al., *Returning to Work After an Orthopaedic Injury.* Orthop Nurs, 2022. **41**(3): p. 198-202.
240. Idarraga, A.J., et al., *Functional capacity evaluation for injuries to the foot and ankle.* Foot & Ankle International, 2019. **40**(11): p. 1282-1287.
241. Idarraga, A.J., et al., *Functional Capacity Evaluation for Work-Related Injuries to the Foot and Ankle is Associated with Low Return to Work Rate.* Foot & Ankle Orthopaedics, 2019. **4**(4).
242. Beckenkamp, P.R., et al., *Prognosis of physical function following ankle fracture: a systematic review with meta-analysis.* journal of orthopaedic & sports physical therapy, 2014. **44**(11): p. 841-851.

243. Sinnott, A.M., et al., *Prevention of Lower Extremity Musculoskeletal Injuries in Tactical and First Responder Populations: A Systematic Review and Meta-Analysis of Randomized Trials From 1955 to 2020.* The Journal of Strength & Conditioning Research, 2023. **37**(1): p. 239-252.
244. Lehman, G.J., *The role and value of symptom-modification approaches in musculoskeletal practice.* journal of orthopaedic & sports physical therapy, 2018. **48**(6): p. 430-435.
245. Abma, F., et al., *The Work Role Functioning Questionnaire v2.0 Showed Consistent Factor Structure Across Six Working Samples.* Journal of occupational rehabilitation, 2018. **28**.
246. Gross, D.P., M.C. Battié, and A.K. Asante, *The Patient-Specific Functional Scale: validity in workers' compensation claimants.* Arch Phys Med Rehabil, 2008. **89**(7): p. 1294-9.

Appendix 1 – Outcome Assessment Tools

Foot & Ankle Ability Measure (FAAM)

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

Please answer __every question__ by circling __one response__ that most closely describes your condition within the past week. If the activity in question is limited by something other than your foot or ankle, check N/A (Not Applicable)

Name ______________________ Date _____________

Activity:	**No Difficulty**	**Slight Difficulty**	**Moderate Difficulty**	**Extreme Difficulty**	**Unable To Do**	**N/A**
Standing	**4**	**3**	**2**	**1**	**0**	☐
Walking on even ground	**4**	**3**	**2**	**1**	**0**	☐
Walking on even ground without shoes	**4**	**3**	**2**	**1**	**0**	☐
Walking up hills	**4**	**3**	**2**	**1**	**0**	☐
Walking down hills	**4**	**3**	**2**	**1**	**0**	☐
Going up stairs	**4**	**3**	**2**	**1**	**0**	☐
Going down stairs	**4**	**3**	**2**	**1**	**0**	☐
Walking on uneven ground	**4**	**3**	**2**	**1**	**0**	☐
Stepping up and down curbs	**4**	**3**	**2**	**1**	**0**	☐
Squatting	**4**	**3**	**2**	**1**	**0**	☐
Coming up on your toes	**4**	**3**	**2**	**1**	**0**	☐
Initiating walking	**4**	**3**	**2**	**1**	**0**	☐
Walking 5 minutes or less	**4**	**3**	**2**	**1**	**0**	☐
Walking approximately 10 minutes	**4**	**3**	**2**	**1**	**0**	☐
Walking 15 minutes or greater	**4**	**3**	**2**	**1**	**0**	☐
Because of your foot and ankle, how much difficulty do you have with:						
Home responsibilities	**4**	**3**	**2**	**1**	**0**	☐
Activities of daily living (eg, around the house)	**4**	**3**	**2**	**1**	**0**	☐
Personal care (eg, bathing, shaving)	**4**	**3**	**2**	**1**	**0**	☐
Light to moderate work (standing, walking)	**4**	**3**	**2**	**1**	**0**	☐
Heavy work (pushing/pulling, climbing, carrying)	**4**	**3**	**2**	**1**	**0**	☐
Recreational activities	**4**	**3**	**2**	**1**	**0**	☐
Column Totals:						

SCORE ______ / 84

Office Use Only:

Scoring:
Each item is scored on a five point scale with 4 being “No Difficulty” and 0 being “Unable To Do.” The lowest potential score of the Activities of Daily Living (ADL) subscale of the FAAM is 0 points, the highest 84 points. Total score is converted into percentage. Higher percentage indicates higher level of physical function

Source: Martin R, Irrang J, Conti S, vanSwearingen J. Evidence of validity for the foot and ankle Ability Measure. Foot Ankle Intern 2005; 26(11):968-983.

Name: ______________________________ Date: ____________

Please answer the 12 questions below. Please check the box that best describes your condition from your injury or during the past 4 weeks.

1. How would you describe the pain you usually have from the foot/ankle in question?
   - 4 ☐ None
   - 3 ☐ Very mild
   - 2 ☐ Mild
   - 1 ☐ Moderate
   - 0 ☐ Severe

2. How long have you been able to walk before severe pain arises from the affected foot/ankle?
   - 4 ☐ No pain for up to 30 minute
   - 3 ☐ 15-30 minutes
   - 2 ☐ 5-10 minutes
   - 1 ☐ Around the house only
   - 0 ☐ Unable to walk at all because of severe pain

3. Have you been able to walk on uneven ground?
   - 4 ☐ Yes, easily
   - 3 ☐ With little difficulty
   - 2 ☐ With moderate difficulty
   - 1 ☐ With extreme difficulty
   - 0 ☐ No, impossible

4. Have you had to use an orthotic (shoe insert), heel lift, or special shoes?
   - 4 ☐ Never
   - 3 ☐ Occasionally
   - 2 ☐ Often
   - 1 ☐ Most the time
   - 0 ☐ Always

5. How much has the pain from the foot/ankle in question affected your recreational activities?
   - 4 ☐ Not at all
   - 3 ☐ A bit
   - 2 ☐ Moderately
   - 1 ☐ Greatly
   - 0 ☐ Totally

6. How much has the pain from the foot/ankle in question interfered with your housework and hobbies?
   - 4 ☐ Not at all
   - 3 ☐ A bit
   - 2 ☐ Moderately
   - 1 ☐ Greatly
   - 0 ☐ Totally

7. Have you been limping when walking because of the foot/ankle in question?
   - 4 ☐ No days
   - 3 ☐ Only one or two days
   - 2 ☐ Some days
   - 1 ☐ Most days
   - 0 ☐ Every day

8. Have you been troubled by pain from the foot/ankle in question in bed at night?
   - 4 ☐ No nights
   - 3 ☐ Only one or two nights
   - 2 ☐ Some nights
   - 1 ☐ Most nights
   - 0 ☐ Every night

9. Have you had swelling of your foot?
   - 4 ☐ None at all
   - 3 ☐ Occasionally
   - 2 ☐ Often
   - 1 ☐ Most of the time
   - 0 ☐ All the time

10. Have you been able to climb a *flight* of stairs?
    - 4 ☐ Yes, easily
    - 3 ☐ With little difficulty
    - 2 ☐ With moderate difficulty
    - 1 ☐ With extreme difficulty
    - 0 ☐ No, impossible

11. After a meal (sitting at a table) how difficult has it been for you to stand up from a chair because of the foot/ankle in question?
    - 4 ☐ Not at all painful
    - 3 ☐ Slightly painful
    - 2 ☐ Moderately painful
    - 1 ☐ Very painful
    - 0 ☐ Unbearable

12. Have you had a severe, sudden shooting/stabbing pain or spasms from the foot/ankle in question?
    - 4 ☐ No days
    - 3 ☐ Only one or two days
    - 2 ☐ Some days
    - 1 ☐ Most days
    - 0 ☐ Every day

Office Use Only:

Score:

Scoring:
Each question is graded from 0-4.
4 = the mildest or least troublesome and
0 = the most severe or most troublesome.

Add the point value for each checked box. A higher score reflects better function; a lower score reflects worse function.

SEFAS is not diagnostic. It should be used to document baseline functional ability, then repeated at 2-4 week intervals to assess progress.

Source: Cöster M, Karlsson MK, Nilsson JÅ, Carlsson A. Validity, reliability, and responsiveness of a self-reported foot and ankle score (SEFAS). Acta Orthop. 2012 Apr;83(2):197-203.