Neck Pain in Adults

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Faculty

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Faculty Disclosure

Contributing faculty, Mark Rose, BS, MA, LP, has disclosed no relevant financial relationship with any product manufacturer or service provider mentioned.

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The division planners and director have disclosed no relevant financial relationship with any product manufacturer or service provider mentioned.

Audience

This course is designed for all members of the interprofessional healthcare team involved in the care of patients with neck pain.

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Course Objective

The purpose of this course is to provide primary care clinicians with the best available evidence on the clinical management of patients with acute or chronic neck pain.

Learning Objectives

Upon completion of this course, you should be able to:

1. Outline the prevalence of neck pain in the United States.
2. Review the personal and societal impact of various types of neck pain.
3. Identify risk factors for neck pain in the general public.
4. Describe the pathophysiology of various types of neck pain.
5. Evaluate key components of the assessment of patients with neck pain.
6. Analyze the role of diagnostic imaging in the evaluation of neck pain.
7. Describe the pharmacotherapeutic options for the clinical management of neck pain.
8. Discuss physiotherapies and traction approaches to the clinical management of neck pain.
9. Review the efficacy of physical and exercise therapies for neck pain.
10. Identify alternative and complementary modalities used in the management of neck pain.
11. Compare and contrast interventional modalities used in the management of neck pain.

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EVIDENCE-BASED PRACTICE RECOMMENDATION

Sections marked with this symbol include evidence-based practice recommendations. The level of evidence and/or strength of recommendation, as provided by the evidence-based source, are also included so you may determine the validity or relevance of the information. These sections may be used in conjunction with the course material for better application to your daily practice.

INTRODUCTION

Acute neck pain can be minor and self-limiting or develop into chronic pain that adversely affects quality of life. Neck pain is the fourth leading cause of disability in the United States, but its negative physical, psychologic, and socioeconomic impact on patients continues to be underappreciated [1; 2].

Primary care clinicians may find neck pain practice guidelines confusing, because recommended approaches are shaped by the training and specialty of guideline authors. This reflects the broader problem of failing to recognize pain medicine as a medical specialty, which has historically fragmented research and practice guidance and made standards of care elusive [3]. With pharmacotherapy studies in neck pain lacking, the focus of neck pain guidelines is nonpharmacologic treatment [4].

A subset of patients experience significant pain relief when structural tissue pathology is identified and treated. However, cervical spine pathology (e.g., disk bulges, degenerative changes) is common in asymptomatic persons, and the longstanding treatment focus on tissue pathology has contributed to poor pain outcomes in these patients. The diverse pain mechanisms produced by specific pathologies are suggested as a treatment focus in chronic neck pain.

By combining the best available evidence from diverse sources, this course can greatly assist healthcare providers in optimizing the care of patients with acute or chronic neck pain.

EPIDEMIOLOGY

Neck pain is very common in the general population, with an annual incidence of 10.4% to 21.3% and lifetime prevalence of 23%. Neck pain can occur repeatedly, and 50% of neck pain seen in primary care settings is in recurrent cases. More than 50% of the middle-aged population shows clinical or radiologic signs of cervical spine disease, which is often asymptomatic [5; 6; 7].

Neck pain encompasses a variety of associated disorders, including whiplash pain and associated disorders (WAD) and other non-traumatic, traumatic, and work-related neck pain [8]. Neck pain and associated disorders account for 10.2 million physician and hospital outpatient visits in the United States each year [8].

Neck pain prevalence is slightly higher in women in their fifth decade of life, and a higher incidence is found in office/computer workers, manual laborers, and healthcare workers. Chronic neck pain is associated with psychologic factors (e.g., anxiety, poor coping skills, somatization), sleep disorders, smoking, sedentary lifestyle, and genetics [9; 10; 11]. Common neck pain comorbidities include headache, back pain, arthralgias, and depression [2; 9].

Higher body mass index increases risk of chronic neck and shoulder pain. Obese persons may be predisposed to neck pain due to systemic inflammation, deleterious structural changes, increased mechanical stress, diminished muscle strength, greater number of psychosocial factors, and greater kinesiophobia-related disability [2; 12].

Treatments used in low back pain are considered applicable to neck pain. The presumptive similarity is generally true, but features of cervical anatomy and physiology make some neck pain conditions distinct from those of other spinal locations. WAD and some collision-related sports injuries (e.g., related to American football, rugby) are unique risk factors for neck pain [2; 9].

In one study, risk of cervical spine injury was evaluated in roller-coaster riders [13]. In 656 neck and back injuries during roller-coaster riding, 72% considered significant were cervical disk injuries. Lumbar spine injuries also included disk herniation or vertebral compression fracture. Passenger testing showed that peak g-force for vertical or axial acceleration (4.5–5.0) and lateral acceleration (1.5) both occurred within 1/10 second (100 ms). The authors concluded a minimum threshold of significant spine injury is not established. Individual susceptibility largely explains the injuries from traumatic loading [13].

PERSONAL AND SOCIETAL IMPACT

As noted, neck pain is the fourth leading cause of disability in the United States (behind low back pain, depression, and arthritic disorders), and in some industries, it accounts for as much time off work as low back pain [1; 2; 14]. In many patients, neck pain becomes chronic, with life-impairing symptoms that severely decrease quality of life and restrict work productivity and daily activities [8].

However, neck pain has received a fraction of the research funding and attention directed to back pain. This reflects a wider underappreciation of its negative physical and psychologic impact, and of the associated high economic burden from medical visits, physiotherapy, pharmacologic and surgical treatments, lost work days, and compensation expenditure [2; 4].

SPECIFIC NECK PAIN CONDITIONS

Whiplash Injury and Whiplash-Associated Disorders

WADs result from rapid acceleration/deceleration, typically involving rear-end or side-impact motor vehicle collisions, and represent 75% of all survivable motor vehicle collision injuries [15]. WAD can also occur from falls, diving, or collisions in contact sports. The "limit of harmlessness" with rear-end collision is 5 to 10 miles per hour (MPH); many whiplash injuries involve rear-end motor vehicle collision at speeds of 14 MPH or less [16; 17; 18; 19]. WAD is associated with significant economic costs from lost work productivity, medical care, legal services, and other disability-related expenses, mostly incurred by patients with chronic symptoms [20].

The annual rate for acute whiplash symptoms is 1 to 6 cases per 1,000 population, and an estimated 1% of adults have chronic whiplash pain. In data from nine U.S. states, 45% of patients with chronic neck pain attributed their pain to a motor vehicle collision [16; 21].

Women show higher rates of WAD, possibly due to less well-developed neck muscles than men. Pre-existing cervical spine pathology predisposes to spinal cord damage in whiplash injuries [19]. Head restraints have greatly reduced whiplash injury rates following rear-end collisions, but they increase whiplash injury risk when poorly fitted [16; 19].

Cervical Radiculopathy

Cervical radiculopathy is cervical spine nerve root dysfunction that causes radiating neck or upper extremity pain or sensory abnormalities [22]. New cases are higher in men (107.3 per 100,000) than women (63.5 per 100,000) annually. Persons 50 to 54 years of age have the highest incidence by age. Overall, the prevalence is 3.5 cases per 1,000 population [22; 23; 24].

Risk factors include manual labor requiring lifting of more than 25 pounds, smoking, operating vibrating equipment, and previous spinal radiculopathy. Over-exertion or trauma antecedents are reported by 15% of patients with cervical radiculopathy [24].

CLINICAL COURSE AND PROGNOSIS

Acute Nonspecific (Idiopathic) Neck Pain

Outcomes for acute idiopathic neck pain are surprisingly poor. Resolution is often incomplete, and prognosis is markedly worse than commonly believed. Statistical pooling of published outcomes showed an average pain severity score (on a 0–100 scale) of 64 at onset, decreasing to 35 at 6.5 weeks, but increasing by 12 months to 42. Disability declined from an average score (0–100) of 30 at onset to 17 by 6.5 weeks, without further improvement at 12 months [25].

After the first 6.5 weeks, no further reduction in neck pain was found. The initial decreases in pain (45%) and disability (43%) are worthwhile to some patients, but the severity of persistent pain (35–42/100 up to one year) is sufficient to interfere with functioning and quality of life. Compared with low back pain one year after onset, neck pain intensity is twice as high and disability is comparable [25; 26; 27].

A comparison of 2,578 patients with WAD or nonspecific neck pain found substantially greater presence of dizziness and memory impairment at initial assessment. Between-group differences in pain and disability increased significantly over 12 months; patients with WAD had an average 2 points greater pain (on a 0–10 scale) and 17% more disability than those with nonspecific neck pain [28].

Acute Whiplash-Associated Disorders

Recovery rates from WAD have been unchanged for decades, with 50% of patients experiencing ongoing pain and disability [15]. Following acute whiplash injury, recovery is slow for pain intensity outcomes, which usually require six months or longer to decrease 20%. Recovery is no better for disability outcomes, with average scores failing to reach 20% improvement by 12 months [29]. Following acute traumatic neck pain (including WAD), patients follow one of three likely trajectories for pain and disability [29]:

- Mild problems with rapid recovery (45% of patients, depending on outcome)
- Moderate problems with incomplete recovery (40%)
- Severe problems with little or no recovery (15%)

Regardless of outcome, recovery is most rapid in the first 6 to 12 post-injury weeks, with considerable slowing after that and little recovery after 12 months [30].

Prognostic Factors in Acute WAD

During acute or subacute WAD, risk factors for persistent problems include [29]:

- High pain intensity
- High self-reported disability (as determined by Neck Disability Index [NDI] score)
- High post-traumatic stress symptoms
- Strong catastrophic beliefs
- Cold hyperalgesia

A meta-review of factors associated with long-term pain and disability after whiplash injury identified post-injury pain and disability, whiplash grade, and cold hyperalgesia as the strongest prognostic factors [31].

Factors unrelated to prognosis include those related to the collision (e.g., impact direction, stationary versus moving, seating position in car). Post-injury imaging findings or motor dysfunction has very weak association with pain/disability prognosis [29; 31]. Compensation and early healthcare use were weakly positive prognostic factors, but equally plausible is reverse causality, whereby poor outcome is the cause of healthcare use and compensation-seeking [31].

Patients suffering from post-motor vehicle collision WAD often litigate to gain more comprehensive medical treatment and monetary compensation for their injury. A long-standing concern of treating physicians is that patients with whiplash may have barriers to recovery—believing they must remain "injured" to collect a settlement [16]. Compensation has been associated with incidence and prognosis, but literature indicates that litigation does not correlate with persistence of pain [32; 33].

Risk factors for poor recovery from whiplash injury described in the medico-legal literature include [16; 34]:

- High post-injury pain (>6/10) and disability (NDI >40%)
- Number and severity of injury-related symptoms (e.g., post-injury headache, low back pain, neuropathic pain, radicular symptoms)
- Psychologic distress (e.g., post-trauma stress symptoms, pain catastrophizing)
- Cervical spine cold hyperalgesia
- Failure to wear seatbelt
- Less than college education

Cervical Radiculopathy

Many patients with cervical radiculopathy secondary to acute disk herniation have a favorable clinical course. Symptom resolution occurs over weeks to months because 40% to 76% of herniated cervical disks spontaneously resorb independent of treatment. Acute neuropathic symptoms in spinal stenosis stabilize or improve in more than 50% of patients, but anatomic derangements do not generally improve without treatment [29; 35; 36].

However, patients with cervical radiculopathy and more severe acute pain or symptoms show higher risk of chronic pain. Higher pain scores and radicular symptoms are associated with chronicity and poor outcomes in both neck pain and low back pain [37; 38].

Assessment of Prognostic Factors

With multiple studies showing that acute-phase risk factors can predict poor pain and disability outcomes, practice guidelines recommend that clinicians assess all patients during initial and follow-up contacts. Pain, disability, post-trauma symptoms, and pain catastrophizing are measured to quantify progress and to predict prognosis for recovery (discussed later) [39].

ASSOCIATED CONDITIONS

Vertigo

Many patients experience vertigo, dizziness, unsteadiness, and other proprioceptive abnormalities following whiplash trauma. Strains to facet joint capsules, paravertebral ligaments, or cervical musculature in WAD are thought to modify proprioceptive cervical balance to produce mild but chronic vertigo [40]. Dizziness may result from injury to facet joints supplied by proprioceptive fibers; when injured, these fibers can send confused vestibular and visual inputs to the brain [41].

Temporomandibular Joint Disorder

Temporomandibular joint disorder (TMD) is associated with whiplash injury, and TMD populations show an average 35% prevalence of whiplash trauma [42]. Chronic muscle pain in TMD is classified as localized or referred. Compared with patients with localized TMD, those with TMD and whiplash histories have greater jaw pain and dysfunction severities; more severe subjective, objective, and psychologic dysfunction; and poorer treatment outcomes. Some evidence suggests TMD pain after whiplash trauma differs pathophysiologically from localized TMD pain. Whiplash trauma is a common TMD comorbidity and probably an initiating or aggravating factor. Patients with TMD and whiplash require early evaluation and multidisciplinary management [43; 44; 45].

PATHOPHYSIOLOGY

This section discusses how neck pain develops and persists by examining pathologic processes in cervical spine and pain signaling structures. Discussion of normal function is presented first to assist in the understanding of pathology.

CERVICAL SPINE STRUCTURE AND FUNCTION

The top seven vertebrae (C1 to C7) make up the cervical spine, which provides mobility and stability to the head while connecting it to the relatively immobile thoracic spine [46]. The spine transfers force between the upper and lower extremities and generates force [47].

C1 and C2 are the upper cervical spine. C1 bears the head ("the globe") and is called the atlas. The atlas connects above with the occiput (the atlanto-occipital joint), where 50% of all neck flexion extension occurs. The atlas connects below with C2, termed the axis, forming the atlanto-axial joint, where 50% of all neck rotation occurs [46]. The lower (subaxial) cervical spine consists of vertebrae C3 to C7, connected by facet joints and intervertebral disks, unlike the complex ligament structures that connect C1 and C2 [48].

Facet joints, also called zygapophysial joints (z-joints), stabilize and limit excessive cervical spine flexion, extension, side-bending, and rotation [49]. The medial branch of the dorsal nerve innervates the facet joint. The joint contains a fibrous capsule, synovial membrane, articular cartilage, and menisci [50].

The intervertebral disk is a functional unit connecting two vertebral bodies of the spine. The disk absorbs shock, accommodates movement, provides support, and separates vertebral bodies to lend height. Disk units have a nucleus pulposus middle, annular fibers (annulus fibrosus) surrounding the nucleus pulposus, and two cartilage end plates that separate each segment level between the C2–T1 vertebrae [51]. Annular fibers are vulnerable to rotational force injury, and nociceptors innervate the middle and outer third [46].

Cervical spine nerve roots exit through small vertebral ports called the foraminal space, above their same-numbered vertebral body; the first cervical spine nerve exits above C1, and the eighth between C7 and T1 [46; 48].

The longitudinal ligaments keep the seven vertebrae and atlanto-occipital joint behaving as a single unit. The ligamentum flavum connects annular fibers (laminae) of adjacent vertebrae and helps the vertebral column resume upright posture after flexion [46].

Nociceptors are sensory receptors of primary neurons in cervical spinal tissue. Nociceptors respond to harmful pressure, temperature, or biomechanical stress (noxious stimuli) by transmitting signals (nociception) to the spinal cord and brain.

CERVICAL SPINE PATHOPHYSIOLOGY

Neck pain can develop from chronic overuse or strain, injury, trauma, or degenerative processes involving bony, articular (disks, facets), nerve (root, spinal cord), or soft (ligament, tendon, muscle) tissues of the cervical spine. In this section, pathologic processes are described that can result in neck pain, starting with acute-onset conditions followed by chronic, degenerative conditions.

Facet-Mediated Pain

Facet joints and capsules are richly innervated by nociceptors sensitive to local stretch or compression. These neurons are activated by abnormal loading or excessive biomechanical stress from whiplash injury or fracture, and sensitized by inflammation and locally released inflammatory promoters (e.g., substance P, phospholipase A). Facet joint pain can develop from degenerative disk or facet joint changes; inflammatory cytokines are found at high levels in facet joint tissue when a degenerative disorder is present. Facet joints are covered by hyaline cartilage and enclosed by synovial capsules, features of other joints that make facet joints vulnerable to osteoarthritis (facet joint arthropathy) [50; 52].

Facet joint pain accounts for 36% to 55% of neck pain and 60% of whiplash pain [50]. The C5–C6 facet joint is the most common origin of cervical, axial, and referred arm pain. Facet joints/capsules largely underlie chronic neck pain, and referred facet pain overlaps with myofascial and diskogenic pain patterns [41].

Cervicogenic Headache

Cervicogenic headache is defined as a unilateral, non-throbbing, non-lancinating head pain caused by referred cervical spine pain. Approximately 70% of cervicogenic headaches originate from the C2–C3 facet joint [53; 54; 55].

The lifetime prevalence of cervicogenic headache is as high as 4.1% in the general population, 17.5% in patients with severe headaches, and 53% in patients with post-whiplash headache [53]. Cervicogenic headache occurs at rates four times higher in women, and the average patient age is 43 years. Migraines often have a cervical pain component and can co-occur with cervicogenic headache [53].

Cervical Strain/Sprain

Cervical strain is injury to the muscle-tendon unit, while cervical sprain is injury to ligamentous structures. Cervical strain/sprain injuries involve flexion, extension, or rotation, with or without axial loading. Acute neck pain frequently involves injury to cervical muscle-tendon or ligamentous structures, which can expand into a range of secondary effects [47]. For instance, edema, hemorrhage, and inflammation can follow elongation and tearing of muscles or ligaments in cervical strain/sprain. Many cervical muscles do not terminate in tendons, but attach to the periosteum (membrane covering a bone surface). Muscles respond to injury by contracting, and recruit surrounding muscles to "splint" the injured muscle. This reflexive tightening (spasm) of paraspinal muscles can cause excruciating pain [56]. Chronic pain following cervical strains usually originates from facet joints, disks, or ligaments [41].

Cervical Myofascial Pain

Cervical myofascial pain also relates to overuse, injury, or trauma and originates from cervical muscles and their surrounding fascia that support the shoulders and neck [57]. Cervical myofascial pain may result as a secondary muscle tissue response to disk or facet-joint injury [41].

Myofascial pain is common in the general population, with 21% of patients in general orthopedic clinics and 85% to 93% of patients in specialty pain management centers having a myofascial pain component. Cervical myofascial pain incidence is disproportionately high in women and peaks in midlife and declines after middle age [57].

Trigger points—the hallmark feature of myofascial pain—are hyperirritable areas in palpable, taut bands of skeletal muscle fiber that elicit local or referred pain. Rapid palpation may elicit a local twitch response, a brisk contraction of muscle fibers around the taut band. Active trigger points generate spontaneous or movement-provoked pain; latent trigger points produce pain when compressed [57].

In cervical myofascial pain, other muscles in the functional unit compensate, promoting a more widespread, chronic problem. Chronicity and disability are strongly linked to pain duration. Recurrence decreases with early treatment initiation to prevent muscle compensation patterns. Migraine and muscle contraction headache frequently co-occur, and TMD can be myofascial in origin [57].

Cervical Disk Disorders

Disk disorders can develop acutely from neck injury or trauma, or through chronic degenerative processes. The C6 – C7 disk is the most frequent herniation site [51]. More common cervical disk disorders include herniated nucleus pulposus, degenerative disk disease, and internal disk disruption.

Herniated Nucleus Pulposus

Herniated nucleus pulposus is localized displacement of the nucleus, cartilage, or fragmented annular tissue beyond the intervertebral disk space. Most cases of herniated nucleus pulposus involve the annulus fibrosus. The four herniated nucleus pulposus subtypes are [51]:

- Disk protrusion: The nucleus pulposus herniates through annular fibers but is confined within the annular margin.
- Disk extrusion: Nucleus pulposus herniation extends beyond the annular margin.
- Disk sequestration: A nucleus pulposus fragment separates from the extruded disk.
- Disk migration: Disk material displaces from the extrusion site.

Herniated nucleus pulposus results from repetitive cervical stress but seldom from a single traumatic incident. Increased risk may accrue with vibrational stress, heavy lifting, prolonged sedentary position, whiplash accidents, or frequent acceleration/deceleration [51]. Disk bulge, whereby disk margins extend past the margins of adjacent vertebral end plates, is not considered a true herniation [51].

TYPICAL DISTRIBUTION OF SENSORY AND MOTOR WEAKNESS IN CERVICAL RADICULOPATHY[a]			
Affected Nerve Root (Frequency)	**Sensory Deficits/Pain Location**	**Muscle Weakness**	**Abnormal Reflexes**
C4 (<10%)	Lower neck, cape-like distribution in upper shoulder	None	None
C5 (10%)	Lateral arm	Deltoid	Biceps
C6 (20% to 25%)	Radial forearm, radial two digits	Biceps, wrist extension	Brachioradialis
C7 (45% to 60%)	Middle finger	Triceps, wrist flexion	Triceps
C8 (10%)	Ulnar two digits	Finger flexors	Finger flexors
[a]Pain referral patterns can vary among patients.			
Source: [2; 22; 56]			*Table 1*

Degenerative Disk Disease

Cervical degenerative disk disease involves degenerative annular tears, loss of disk height, and nucleus pulposus degradation. It is commonly age-related and affected by poor nutrition, smoking, atherosclerosis, job-related activities, and genetics. It is important to remember that degenerative disk changes seen by x-ray may reflect natural aging and not painful pathology [51].

Internal Disk Disruption

Internal disk disruption describes pathologic annular fissuring within the disk, without external disk deformation. Internal disk disruption can result from cervical trauma-related nucleus pulposus degradation, cervical flexion/rotation-induced annular injury, or whiplash [51].

Chemical Radiculitis

Herniated or degenerated nucleus pulposus releases inflammatory promoters (e.g., phospholipase A2, prostaglandin E2, proteoglycans, cytokines, tumor necrosis factors) and mediators (e.g., substance P, bradykinin, potassium, histamine). This inflammatory cascade can cause chemical radiculitis, characterized by intense chemical irritation of cervical spine nerve roots, radicular pain, and most herniated nucleus pulposus pain [24; 51; 58].

Cervical Radiculopathy

In cervical radiculopathy, compression or irritation of a cervical spine nerve root, typically by herniated disk material, chemical radiculitis, or stenosis, results in radiating pain, weakness, or numbness [22; 23; 58].

Most cervical radiculopathies involve C7 or C6 nerve root levels, but all root levels exhibit motor, sensory, and reflex abnormalities that follow specific dermatomal or myotomal distribution patterns in the neck and upper extremities (***Table 1***) [2; 22; 56].

Mechanical compression induces nerve deformation and malfunction when external pressure exceeds intraneuronal pressure. This results in conduction block, interruption of axonal flow, vascular sequelae (e.g., hypoxia), and accumulation of metabolic byproducts [22; 58]. Nerve root compression alone may not be painful unless inflammation is present. Narrowing of the foraminal space (foraminal stenosis) encroaches on the exiting spinal nerve, and foraminal stenosis from disk or facet joint degeneration accounts for many cervical radiculopathy cases [51].

Cervical Spinal Stenosis

In the C3–C7 spinal canal, the normal anteroposterior diameter is 17–18 mm. The spinal cord requires 10–11 mm; an anteroposterior diameter <10 mm is absolute spinal canal stenosis, and 10–13 mm is relative stenosis [59; 60].

In acquired cervical spinal stenosis, degenerative disk or facet disease pathologically narrows the canal in middle-aged and older patients. Cervical spondylosis (arthritis) may progress to stenosis, and stenosis to cervical spondylotic myelopathy, but this sequence is variable and difficult to predict. However, adults with asymptomatic stenosis show age-related increases in cervical spondylosis. Congenital cervical spinal stenosis occurs in younger, athletic patients when bony anomalies narrow the spinal canal diameter <13 mm [59; 61].

Cervical Whiplash Injury

In cervical whiplash, diverse symptoms develop following a rapid sequence of injuries [16; 19; 62]. The first is cervical hyperextension injury. A driver/passenger is struck from behind, which throws the body forward, but the head lags to hyperextend the neck. When the head and neck reach maximum extension, the neck snaps into flexion. The head is then thrown forward, flexing the cervical spine and resulting in rapid deceleration injury. The chin truncates forward flexion, but it can remain sufficient to cause longitudinal distraction and neurologic damage. Hyperextension may occur in the subsequent recoil. Within 100 ms, the cervical spine is compressed from below; as lower segments extend with upper segments flexed, the cervical spine assumes an S-shaped curve. In a split-second, all cervical segments are forced backward into extension. Whiplash-like loads of combined shear, bending, and compression forces can injure facet joints/capsules, and facet injury is the most common source of chronic post-whiplash pain. Spinal bones, ligaments, muscles, tendons, and disks may also become injured [41; 63; 64].

The diverse constellation of post-whiplash symptoms, termed WAD, reflects the range of potentially injured tissue. Symptoms can include neck pain and stiffness, occipital headache, thoracic or lumbar pain, and referred pain or numbness to shoulders, arm, or scapula. Paraspinal muscle tightness and spasm, neck tenderness, and reduced range of movements are common. Patients may also experience headache, jaw pain, fatigue, dizziness, vertigo, blurred vision, or nausea. Insomnia, depression, and general anxiety or travel anxiety when in a car can follow acute whiplash. Symptoms can be severe, often without imaging abnormalities [16; 19].

Degenerative Disorders of the Cervical Spine

As noted, x-rays show degenerative cervical spine abnormalities in many asymptomatic adults, making the boundary between normal aging and disease difficult to define. Even severe degenerative changes can be asymptomatic but can eventually lead to neck pain or neurologic complications [14]. Vertebral body, disk, and facet joint degeneration decreases foraminal and canal width, initiates inflammatory processes, and promotes nerve compression/irritation, chronic neck pain, and progressive radiculopathy symptoms [14; 23; 24; 51; 58; 61; 65; 66].

Cervical Spondylosis

Cervical spondylosis is osteoarthritis, a chronic degenerative disorder that affects cervical vertebral bodies, intervertebral disks (as disk herniation and spur formation), and contents of the spinal canal (i.e., nerve roots and/or spinal cord). It may also affect the facet joints and longitudinal ligaments, but this is debated [65].

Cervical Facet Joint (Z-Joint) Arthropathy

Facet joint arthropathy describes osteoarthritis and degenerative changes in facet joints and usually follows the development of cervical degenerative disk disease. The degenerative changes resemble those of other joints, including osteophyte formation, osteosclerosis, thinning of articular cartilage, and hypertrophy (thickening) of the facet joint capsule, ligamentum flavum, and articular process. Facet joint hypertrophy distorts articular surfaces, leading to axial or referred pain [49].

Cervical Spondylotic Myelopathy

Cervical spinal cord compression causes cervical spondylotic myelopathy, the most serious degenerative disorder consequence. Reversible neurologic deficits occur with cord compression of 40% or greater [61]. Abnormal movement and cervical spondylotic myelopathy symptoms can develop from cervical spinal cord damage with traumatic compression or ischemia from arterial compression or cervical spondylosis [60; 65]. In patients with cervical spondylotic myelopathy, co-occurring cervical radiculopathy is frequent and co-occurring stenosis is occasional [65].

NECK PAIN PATHOPHYSIOLOGY

In most patients with chronic neck pain, identifying and treating the pain mechanism(s), rather than spinal tissue pathology, is more effective. Pain from tissue injury or disease that resolves with tissue healing is a symptom of the tissue damage, and resolution typically occurs within three months of onset.

Pain becomes a disease entity (rather than a symptom) when it persists after healing or resolution of the original tissue insult [3]. Chronic (more than three months) neck pain can develop from acute pain of any cervical spine origin, but it is substantially more difficult to control and can be severely consequential to patients [2; 67].

Normal Pain Processes

The somatosensory system enables the perception of pain, touch, pressure, temperature, position, movement, and vibration. This system begins with receptors of peripheral sensory neurons (nociceptors) in skin, muscles, joints, and fascia (peripheral tissue). In response to potentially harmful pressure, temperature, or biomechanical stress (noxious stimuli), nociceptor fibers send signals to the dorsal root ganglia (containing the cell bodies of sensory neurons), which are relayed to the dorsal horn of the spinal cord. In the dorsal horn, primary neurons synapse with second-order nociceptive neurons. The noxious stimuli signal is sent up ascending spinal pathways to the brain. The brain interprets pain signal intensity and location, assigns meaning, activates fear or anxiety, and initiates appropriate motor responses. The brain then signals back the spinal dorsal horn, via descending pathways, to inhibit or facilitate incoming nociceptive stimuli. Thus, pain transmission signals travel up the spinal cord for processing and interpretation in the brain, which responds by pain modulation signals down descending pathways to the spinal dorsal horn. This bi-directional feedback circuit balances signaling facilitation and inhibition; normal function is maintained.

Chronic Pain Pathophysiology

With normal somatosensory function, pain from tissue injury or damage resolves during or before tissue healing or resolution. In contrast, chronic pain develops as somatosensory function becomes pathologic [41; 68; 69; 70; 71]. Mechanical/inflammatory injury of peripheral sensory nerve fibers activates the function of their ion channels (e.g., sodium, calcium). This increases excitatory synaptic transmission in dorsal horn neurons and nociceptive circuits.

Intense nociceptive bombardment in the dorsal horn impacts synaptic activity, where primary neurons signal second-order neurons. The bombardment induces synaptic release of excitatory amino acids and neuropeptides (e.g., substance P, glutamate), which bind post-synaptic receptors of second-order neurons in the dorsal horn. In altered second-order spinal cord neurons, excessive *N*-methyl-D-aspartate (NMDA) and α-amino-3-hydroxy-5-methyl-4-isoxazolepropionic acid (AMPA) signaling reflects a hyperexcitability state that amplifies sensory responses; central sensitization develops.

In this state, brainstem control of descending pain modulatory pathways becomes impaired; balance between descending inhibition and excitation is altered, and excitation dominates. Pain perception is facilitated by ascending pain pathway sensitization and disinhibited by impaired descending inhibitory. The brain now receives altered, abnormal sensory messages.

Pain Modulation

Nociceptor activation does not necessarily produce pain. Some persons with marked spinal pathology are asymptomatic, while others experience severe, chronic, disabling pain without apparent structural pathology. Patient responses to analgesic therapy also vary substantially. A key factor in this pain response variability is how the pain message is modulated in the central nervous system (CNS).

The pain signal can be augmented or diminished as it ascends from its dorsal horn entry point to the CNS and arrives in the cerebral cortex (which mediates awareness). An assumed correlation between peripheral tissue pathology and pain intensity is subject to modification and interference in the various pathways [69; 72; 73; 74]. Without treatment, CNS pain modulation abnormalities persist and may become refractory to intervention [75; 76].

Transitions in Chronic Whiplash Pain

Post-whiplash pain is the most-studied chronic neck pain condition, with cervical facet joints key pain contributors. Facet joint structure may pathologize as chronic post-whiplash pain develops [50].

Following acute tearing of the facet joint capsule or stretching beyond its limits, the joints fill with fluid and distend, causing pain and limiting cervical range of motion. In the subacute phase, inflammatory changes develop from vasodilation and invasion of inflammatory cytokines, promoting degeneration. Laxity from joint capsule hypertrophy and distention impinges a nerve root exiting the spinal canal or neuroforamen; radiating symptoms or radiculopathy develops. Chronic inflammation leads to central sensitization, with pain stimuli thresholds decreasing and pain signal firing rates increasing. Facet capsule fibrosis and osteophyte formation further restrict segmental motion.

Psychologic Factors in Chronic Neck Pain

Psychologic factors contribute to the development of chronic neck pain and disability in some patients. In the fear-avoidance model, key psychologic processes, including emotions, cognitions, attention, and behaviors, converge to form fear-avoidance beliefs and behaviors, which become drivers of pain-related disability. Fear develops in response to negative cognitions, exaggerating both the potential threat of pain and the negative interpretation of pain-related health information. Pain catastrophizing refers to this exaggerated set of pain-related cognitions, often appearing as anticipation of the worst possible outcome [77; 78]. Fear focuses the attention on pain and related symptoms, leading to a hypervigilant state and avoidance of activities (e.g., occupational, social) and movements (e.g., walking, physical therapy) perceived to possibly worsen pain [79].

Evidence connects pain, stress response, and prognosis following whiplash. After whiplash injury, the presence of hyperalgesia (amplified pain sensitivity), stress-related symptoms, and pain catastrophizing is linked to higher initial pain and disability, and strongly predicts poor functional recovery [80]. Hyperalgesia is a consequence of inflammatory processes. Intense stress exposure (as with acute trauma) can release cytokines that signal infection or inflammation, and a relationship between catastrophizing and inflammation has been identified [81]. Hyperalgesia and stress-mediated responses/symptoms in whiplash-injured patients with poor prognosis suggests contribution of inflammatory processes [82; 83].

Other evidence expands the understanding of how psychologic factors may influence pain. High levels of perceived injustice following whiplash injury have been associated with prolonged work disability at follow-up, suggesting a modifiable risk factor for psychologic intervention [84]. A study of whether social pain from rejection promoted social anxiety two days later identified a link between emotional

and physical pain [85]. Participants rejected during an initial social situation had higher social anxiety before and during a second situation (versus those not rejected), fully mediated by initial social pain intensity. Next, all participants in a social situation were rejected, and randomized to acetaminophen or placebo before the next social situation. Acetaminophen lowered social anxiety before and during this exposure. Roughly 50% of this effect was mediated by, and specific to, reduction in social pain and not social anxiety [85].

Attachment insecurity (i.e., anxiety and/or discomfort in close relationships) is associated with physical symptoms, medically unexplained symptoms, and painful conditions. Medically unexplained chronic pain has been associated with attachment insecurity, after adjusting for depressive and anxiety disorders [86].

New Directions in Chronic Neck Pain Practice

Fewer than half of patients with chronic pain achieve at least 50% pain reduction with any single drug or their combinations, a consequence of [70; 87; 88]:

- Limitations of neuropathic pain definitions and the "nociceptive-neuropathic dichotomy" of chronic pain mechanisms
- Standard practice guidelines based on clinical trials that assess analgesic efficacy in patients with specific underlying pathologies, but not pain types
- Multiple pain mechanisms in most chronic pain, but most drugs target one pain mechanism

These flaws have prompted intensive efforts to overhaul chronic pain research and practice, leading to publications that expand and clarify chronic pain mechanisms to improve pain assessment and treatment. Many findings in chronic low back pain are relevant to chronic neck pain and are summarized here. Implementation in neck pain assessment and treatment is discussed in later sections.

Neuropathic pain definitions are often over-restrictive, with pain strictly tied to a lesion or disease in nerve structures, such as peripheral nerves (e.g., post-herpetic neuralgia, diabetic neuropathy) or spinal nerve roots (e.g., radiculopathy). In this model, without evidence of nerve lesion or disease, signs or symptoms are insufficient [89; 90].

Current chronic low back pain guidelines class 85% to 90% of patients as nonspecific pain and a fraction as neuropathic pain, but many patients with chronic low back pain present with symptoms of a neuropathic component that goes undetected and untreated because nerve lesion or disease is absent [91; 92; 93; 94]. Their misclassing as nociceptive or nonspecific pain may lead to poor treatment outcomes [93; 94].

Neuropathic pain can develop when nerve fibers in any segment of the somatosensory system become dysfunctional or transmit signals inappropriately—without lesion or disease [95; 96]. The painDETECT questionnaire (PDQ) was developed to identify neuropathic components in patients with chronic low back pain considered nociceptive [67; 87; 97]. This tool characterizes "altered nociception" as a distinct pain phenotype in chronic low back pain. In these patients, neuropathic-like signs and symptoms reflect maladaptive nervous system functioning and central rather than peripheral pain mechanisms [94; 98].

Other advances are improving pain mechanism assessment. Sensory profile (pain-related sensory signs and symptoms) testing in 902 patients with diverse neuropathic pain etiologies identified distinct sensory profile subgroups: sensory loss (42%), thermal hyperalgesia (33%), and mechanical hyperalgesia (24%). All sensory profile subgroups occurred across etiologies, reflecting pain-related signs and symptoms that differ in neurobiologic mechanisms and treatment response [97].

With the nociceptive-neuropathic dichotomy of chronic pain mechanisms outdated, research has led to "altered nociception" as a proposed pain mechanism descriptor when chronic pain is neither nociceptive (tissue damage) or neuropathic (nerve pathology) [88; 93; 94; 99]. Maladaptive CNS neuroplasticity in chronic pain has been recognized since the early 2000s as a disease process of its own right, and translation into clinical practice is needed [100]. Recognizing this, in 2017, the International Association for the Study of Pain (IASP) introduced the term "nociplastic pain," which is defined as "pain that arises from altered nociception despite no clear evidence of actual or threatened tissue damage causing the activation of peripheral nociceptors or evidence for disease or lesion of the somatosensory system causing the pain" [99]. Additionally, in 2021, the IASP released clinical criteria and a grading system for nociplastic pain affecting the musculoskeletal system [101].

ASSESSMENT AND DIAGNOSIS

PATIENT HISTORY

Assessment of neck pain begins with a thorough history and physical exam. This information guides further diagnostics and clinical management. The top priority is to identify potentially serious underlying pathologies, termed "red flag" conditions (***Table 2***). While infrequently encountered, neck pain-related signs or symptoms that suggest serious disease require immediate investigation and intervention. "Red flags" should be assessed throughout the evaluation process, and imaging confirmation is necessary when clinician suspicion remains [7; 102]. After obtaining basic patient demographics, a detailed history is taken [7; 8; 56; 102; 103].

To assess the history of the present illness, clinicians should inquire regarding:

- Pain details
  - Quality
  - Onset
  - Duration
  - Severity
  - Location
  - Time course
  - Progression
- Modifying factors
  - Rest/activity
  - Changes in position
  - Weight-bearing
  - Time of day (e.g., at night, on awakening)
  - Tolerance for neck flexion
- Associated symptoms
  - Stiffness
  - Numbness
  - Paresthesia
  - Weakness
  - Urinary retention
  - Constipation
  - Urinary/fecal incontinence
- Primary/secondary complaints
  - Primary neck pain
  - Secondary arm pain
  - Headaches
  - Shoulder girdle complaints
- Radiating symptoms
  - Presence and distribution of upper/lower extremity numbness, paresthesia, or weakness
  - Percentage of axial versus peripheral pain (e.g., 90% neck versus 10% upper limb)
  - Precipitated by coughing or sneezing, or alleviated by raising the affected arm over the head
- Initial treatment of present complaint
  - Emergency department
  - Acute care or clinic evaluation
  - Imaging
  - Analgesics given and symptom response

"RED FLAG" FEATURES IN NECK PAIN		
Red Flag	**Potential Conditions**	**Associated Signs and Symptoms**
Trauma (fall, motor vehicle accident, whiplash injury)	Vertebral fractures, spinal cord injury/syrinx, ligamentous disruption	Loss of or alternating consciousness, cognitive deficits, traumatic brain injury, headaches, neurologic symptoms
Rheumatoid arthritis, Down syndrome, spondyloarthropathy	Atlantoaxial subluxation	Easily fatigued, gait abnormalities, limited neck mobility, torticollis, clumsiness, spasticity, sensory deficits, upper motor neuron signs
Constitutional symptoms	Metastases, infectious process, systemic rheumatologic disease	Weight loss, unexplained fevers, anorexia, family or personal history of malignant neoplasm, diffuse joint pain and stiffness, abnormal laboratory test results
Infectious symptoms	Epidural abscess, spondylodiskitis, meningitis	Fever, neck stiffness, photophobia, elevated white blood cell count
Upper motor neuron lesion	Spinal cord compression, demyelinating disease	Hoffmann sign, hyper-reflexia, Babinski sign, spasticity, incontinence, sexual dysfunction
Age younger than 20 years	Congenital abnormalities (cervical spina bifida, Scheuermann disease)	Birthmarks, overlying skin tags, patches of hair, family history, systemic disease (diabetes, epilepsy for spina bifida)
	Conditions associated with substance abuse (e.g., infection)	Male sex, poor work or school performance, depression or other psychiatric morbidity
Concurrent chest pain, diaphoresis, or shortness of breath	Myocardial ischemia or infarction	Nausea, extension of pain into the left arm (especially medial upper arm)
Age older than 50 years	Metastases, vertebral fracture, carotid or vertebral artery dissection/ bleeding	Family or personal history of malignant neoplasm, previous trauma Arterial dissection: tearing sensation, headache, visual loss, or other neurologic sequelae
5 Ds and 3 Ns	Vertebrobasilar ischemia, carotid artery dissection	Diplopia, dizziness, drop attacks (syncope), dysarthria, dysphagia, ataxia of gait, nausea, numbness, and nystagmus
Source: [2]		*Table 2*

Spinal pain history should include information regarding:

- Known neck or back disorders (e.g., osteoporosis, osteoarthritis, disk disorders, recent or remote injury)
- Specific prior treatment, including surgery
- Chronic or recurrent symptoms
- Functional limitations
- History of motor vehicle collisions (if whiplash suspected)
- Risk factors for:
  - Back disorders (e.g., cancer, osteoporosis)
  - Aneurysm (e.g., smoking, hypertension)
  - Infection (e.g., immunosuppression, IV drug use, recent surgery, hemodialysis, penetrating trauma)
- Extra-articular features of an underlying systemic disorder (e.g., diarrhea, abdominal pain, uveitis, psoriasis)

Patients should also be assessed regarding their medical history and a general review of systems. Any history of neoplasm, gout, arthritis, hypertension, or fractures should be noted. The review of systems will include current symptoms of systemic diseases:

- Infection (e.g., fever, sweats, chills)
- Cancer (e.g., weight loss, poor appetite)
- Multifactorial spinal pain (e.g., fatigue, depressive symptoms, headaches)
- Esophageal disorders (e.g., worsening neck pain during swallowing)
- Gastrointestinal (GI) disorders (e.g., anorexia, nausea, vomiting, changes in bowel function or stool)
- Urinary tract disorders (e.g., urinary symptoms, flank pain)
- Pulmonary disorders (e.g., cough, dyspnea, worsening pain during inspiration)

Medication use, smoking history, and diabetes risk should also be assessed.

ASSESSMENT OF PROGNOSTIC FACTORS

Clinicians should perform functional assessments during initial contact and all follow-ups and a psychosocial ("yellow flag") assessment during initial or follow-up visit to obtain important information about baseline status, trajectory, and prognosis of recovery. Both assessments are easily conducted using validated self-report questionnaires.

Functional Assessment

The Visual Analog Scale (VAS), the Numerical Pain Rating Scale (NRS), the NDI, the Neck Pain and Disability scale (NPAD), the Pain Catastrophizing Scale (PCS), and the Impact of Events Scale-Revised (IES-R) measure clinical variables with significant prognostic value in acute neck pain; all may be used for the initial assessment and follow-up. Patients with high initial scores are at much greater risk of persistent pain and disability and may require treatment of greater intensity or focus. Clinical factors and cutoff scores for poorer prognosis [22; 29; 39; 104]:

- Pain severity: High pain intensity (NRS or VAS score ≥6 on a 1–10 scale)
- Interference with daily activities: Evaluates pain impact on personal care, lifting, reading, concentration, work, driving, sleeping and recreation; pain intensity, and headaches. High self-reported disability is defined as an NDI score of ≥30%.
- Pain catastrophizing: Belief that pain is to be feared or may be severely disabling. High pain catastrophizing is defined as a PCS score of ≥20.
- Acute post-traumatic stress symptoms: The IES-R evaluates post-traumatic stress symptoms, not post-traumatic stress disorder (PTSD). High acute post-traumatic stress symptoms is defined as an IES-R score of ≥33.

"Yellow Flag" Assessment

The Tampa Scale of Kinesiophobia (TSK), the Fear Avoidance of Pain Scale (FAPS), the Patient Health Questionnaire-9 (PHQ-9), and the Hospital Anxiety and Depression Scale (HADS) measure "yellow flags," psychosocial conditions that may predispose the patient to a more complex clinical course, chronicity, or disability [8; 19; 103]. The following psychologic factors should be identified and measured using the associated tools:

- Pain catastrophizing: PCS
- Kinesiophobia, or avoiding activities due to fear of pain (fear-avoidance behavior): TSK or FAPS
- Passive coping: PCS
- Depressed mood or feelings of depression about pain: PHQ-9 or HADS
- Anxiety or fear about pain: TSK or FAPS
- Pessimism and poor recovery expectation: Ask the patient: Do you think that your injury will...
  - Get better soon
  - Get better slowly
  - Never get better
  - Don't know

- High levels of frustration or anger about pain. Ask the patient to quantify (on a 0–10 scale) how frustrated (angry) he or she feels about the pain.

Obtain during history:

- Past/current social or financial problems
- Past/current multiple medical diagnoses, unresolved musculoskeletal conditions
- Past/current history of physical abuse, emotional abuse, chronic pain
- Past/current active substance abuse

Sleep Assessment

Sleep quality and pain are intimately linked, making sleep important to assess. For every 1-point decrease in sleep quality (on a 0–3-point scale), pain intensity increased 2.08 points (on a 0–10-point scale) among 1,246 patients with acute low back pain [105]. This large effect of poor sleep on subsequent pain intensity was unrelated to depression or other common factors.

Among 1,016 patients with chronic low back pain or neck pain, 42.22% experienced sleep deprivation (less than six hours per night) and 19.88% experienced serious sleep impairment (less than four hours per night), even when using analgesics. Severity of sleep impairment strongly correlated with pain intensity score and pain chronification grade but did not differ between low back pain and neck pain [106].

PHYSICAL EXAMINATION

The physical exam supports patient history findings, screens for serious pathology, informs further diagnostic work-up, and guides treatment selection. Neck pain origin is important to identify (when possible) and document, but underlying pathology of neck pain is seldom curable, and its treatment targeting has led to inadequate outcomes. Specific pathologies can generate different pain types, and the importance of pain type assessment and treatment is now stressed.

Characterizing neuropathic pain and identifying neuropathic components in chronic nociceptive neck pain are essential tasks during the physical exam. Sensory, motor, and reflex testing during the physical exam, assessment, and provocative tests assist in this task [2; 19; 29; 41; 94; 103; 107].

General Visual Inspection

Observe patient to identify nonverbal facial or behavioral pain expressions. Gait abnormalities can reflect spinal cord (myelopathy) or brain injury. Note traumatic or developmental abnormalities. Assess gait, posture, stance, rapid walking, balance, and visible deformities.

Palpation

Palpate the spine, facets, and paravertebral muscles for tenderness, muscle spasm, myofascial tightness, and trigger points. Painful facets can reflect osteoarthritis or post-traumatic irritation of the joint capsule.

Thoracic Spine and Shoulder

Examine shoulder for range of motion impingement and rotator cuff function.

Motor and Sensory Examination

Evaluate upper muscle groups with specific nerve root focus; assess sensation to light touch, pin prick, temperature, position, and vibration. A >2 cm difference in circumference of two upper extremities may indicate muscle atrophy; motor and sensory differences may implicate a specific nerve root.

Reflex Testing

Asymmetry of deep tendon reflexes may indicate pathology. Inverted reflexes (e.g., arm flexion or triceps tap) may indicate nerve root or spinal cord pathology at the tested level. Pathologic reflex tests include wrist clonus, grasp reflex, and Hoffman sign. In patients with suspected malingering or who report severe pain in the absence of pain-related behaviors, reflexes may be the only objective exam tool.

Cervical Range of Motion

During rotation, flexion, and extension, assess quality of motion and for presence of muscle spasm. Motion evaluation of specific joints may be indicated. Do not assess in acute trauma cases until fracture and instability are ruled out.

Cervical range of motion is often limited in all patients with neck pain, but aggravating and alleviating factors and specific exacerbating movements may provide clues to the pain origin and inform decisions to concerning further work-up. Pain-exacerbating movements and suggested pain origin include [2; 14]:

- Turning or bending head ipsilateral to source: Radicular or facet pain
- Contralateral turning of head: Myofascial origin
- Arm pain aggravated by neck extension: Spinal stenosis
- Arm pain aggravated by neck flexion toward affected side: Foraminal stenosis and/or radiculopathy
- Forward flexion: Diskogenic origin
- Morning stiffness: Facet joint pain due to arthritis
- Severe unrelenting pain unaffected by rest or position changes: Assess for "red flags" (e.g., malignancy, primary neurologic disorder, infection)

Neuropathic Neck Pain

Cervical radiculopathy is the most common neuropathic neck pain. Distribution of abnormal sensations or pain can follow patterns specific to the innervated skin (dermatome) of the involved nerve root, and less commonly, other innervated structures that include muscles (myotome), joints, or ligaments (sclerotome) [22]. Symptom distribution with mechanical stimulation of nerve roots (dynatome) differs from dermatomal patterns (although they may overlap). Cervical disk herniation may induce thermal distributions (thermatome). Radiculopathy can occur without pain, and distribution patterns vary among patients [51].

Cervical radiculopathy can result from nerve root irritation (chemical radiculopathy) or compression (e.g., disk herniation, foraminal stenosis, cord compression in myelopathy) [2; 29; 51].

The origins of radiating neck pain/sensory disturbance are [7; 107]:

- Cervical radiculopathy: Sensory, motor, and reflex abnormalities, with pain/sensory distribution from the affected nerve, weakness/tenderness of muscles innervated by the nerve, and hypoactive deep tendon reflexes of the same muscle.
- Radicular pain: Sharp, shooting, burning, or aching pain that radiates along the course of a nerve root—without neurologic abnormalities. Neck, upper trapezoid, or scapula tenderness is common.
- Referred pain: Pain radiates into the neck, head, upper trapezoid, scapula, or upper arm, but does not involve spinal nerve roots and is non-neuropathic (sensory, motor, reflex changes).

The Self-Report Leeds Assessment of Neuropathic Symptoms and Signs (S-LANSS) pain scale can help differentiate neuropathic from nociceptive pain [2; 91; 108].

Neuropathic Components in Neck Pain

Chronic non-radiculopathic neck pain may have a neuropathic component without apparent nerve root or spinal cord pathology, reflecting CNS alteration [94]. Assessment of a neuropathic component is performed by the physical exam and the PDQ tool [67; 69; 70; 71]. The cardinal features are spontaneous pain (arising without stimuli), abnormal pain response to normally non-painful stimuli such as light touch or moderate heat/cold (allodynia), and exaggerated response to mildly painful stimuli (hyperalgesia). The spontaneous pain may be paroxysmal (e.g., shooting, stabbing, electric shock-like), dysesthetic (e.g., unpleasant abnormal sensations of touch, for example prickling, pins and needles, or crawling), or abnormal thermal sensations (e.g., burning, ice cold). These signs and symptoms can co-occur with loss of afferent sensation.

PROVOCATIVE TESTS: DESCRIPTION AND DIAGNOSTIC USE	
Test	**Description**
Cervical radiculopathy	
Spurling	Radicular pain reproduced by lateral flexion and rotation to affected side with axial compression of the head
Shoulder abduction	Ipsilateral cervical radicular symptoms relieved by placing symptomatic arm on head (abduction)
Neck distraction test	Radicular symptom relief when examiner grasps patient's head under occiput and chin and applies 10–15 kg of axial traction force
Valsalva maneuver	Radicular pain reproduced by forced expiratory effort with mouth and nose closed
Jackson compression	Downward pressure on head with lateral flexion
Upper limb tension test 1 (median nerve bias)	Radicular pain reproduced with scapular depression; shoulder abduction; forearm supination, wrist and finger extension; shoulder external rotation; elbow extension; contralateral followed by ipsilateral cervical lateral flexion
Upper limb tension test 2A (median nerve bias)	Radicular pain reproduced with scapular depression; elbow extension; lateral rotation of the whole arm; wrist, finger, and thumb extension
Upper limb tension test 2B (radial nerve bias)	Radicular pain reproduced with scapular depression; elbow extension; medial rotation of the whole arm; wrist, finger, and thumb flexion
Upper limb tension test 3 (ulnar nerve bias)	Radicular pain reproduced with scapular depression; shoulder abduction; shoulder external rotation; wrist and finger extension; elbow flexion; shoulder abduction
Upper limb tension test (musculocutaneous)	Radicular pain reproduced with scapular depression; elbow extension; shoulder extension; ulnar deviation of the wrist with thumb flexion. Either medial or lateral rotation of the arm could further sensitize this nerve.
Cervical myelopathy	
Lhermitte sign	Electrical-like sensations down spine or arms with passive flexion of neck
Hoffmann sign (also for spinal stenosis)	Reflex contraction of thumb and index finger from nipping of the middle finger
Babinski sign	Stimulation of the foot sole elicits dorsiflexion of hallux, or dorsiflexion and abduction of other toes
Hyper-reflexia	Over-reactive deep tendon reflexes
Clonus	More than two repetitive beats during wrist or ankle dorsiflexion movements
Facet joint pain	
Paraspinal tenderness	Paraspinal > midline pain with palpation. The only test that identifies facet pain, distinguishes from diskogenic pain, and predicts treatment response.
Source: [2; 29; 49; 51; 56]	*Table 3*

The PDQ is extensively used worldwide in research and clinical practice to identify neuropathic components in chronic spinal pain. A PDQ score greater than 18 indicates a significant neuropathic pain component, regardless of radiculopathy presence [94].

Provocative Tests in Neck Pain Assessment

Some specialist and primary care practice guidelines recommend provocative tests (***Table 3***). They can be helpful adjuncts to history and physical exam findings in identifying potential neuropathic pain origins. These tests are not diagnostic alone, and clinicians should look for patterns in patient-reported, physical exam, and provocative test findings to rule in or rule out specific painful pathologies [29].

EVIDENCE-BASED PRACTICE RECOMMENDATION

According to the Royal Dutch Society for Physical Therapy, the Spurling test and the traction/distraction test are considered to be valid as specific tests for ruling in cervical radiculopathy. (http://stoverpt.com/uploads/3/4/8/2/34823947/neeck_pain_guidelines.pdf. Last accessed September 23, 2022.)

Level of Evidence: Expert Opinion/Consensus Statement

DIAGNOSTIC IMAGING

Diagnostic imaging has an essential role in some neck pain presentations. However, imaging findings of bulging disks or degenerative changes are common in asymptomatic persons and increase with age [14; 103]. In some patients, the imaged abnormality is causing their neck pain. In most patients with acute neck pain, imaging fails to identify a pathologic cause or pathologic findings have uncertain relevance or do not change the course of treatment [29].

Imaging can produce false positive (abnormalities are inert) or false negative (pathology undetected) results. Clinicians should correlate imaging results with history and physical exam findings before deciding its relevance to patient symptoms [102].

Imaging results should be presented with patient education on prevalence, treatment, and prognosis. Patients may intensely want a clear-cut diagnosis of their neck pain. Neglecting this education increases the risk of patient fixation on the imaging abnormality (which may be inert), subsequent pursuit of "cure" for the assumed diagnosis, and with failed expectations, initiation into a chronic cycle that may have been prevented [102; 103].

For these reasons, clinical practice guidelines state that patients with acute cervical spine injury, suspected "red flag" conditions, or suspected radiculopathy (and a few select presentations) should receive initial imaging, with imaging considered in other patients remaining symptomatic three to six weeks later [102; 103].

Diagnostic Imaging Modalities

Imaging tests differ in accuracy for various pathologies, and no imaging test alone assures correct diagnosis. Information from patient history and physical exam should correlate with imaging results [103].

The indications in the following sections pertain to patients remaining symptomatic after four to six weeks of conservative therapy or with new onset or progression of neurologic symptoms at any follow-up time.

Plain Radiography

X-ray images are taken from different anatomic views to identify the following abnormalities [51]:

- Anteroposterior: Tumors, osteophytes, fractures
- Lateral: Stability, spondylosis (spurring, disk space narrowing)
- Odontoid: C1–C2 stability, odontoid process (bony projection of C2, prone to fracture)
- Bilateral oblique: Degenerative disk disease, foraminal encroachment by osteophytes
- Flexion-extension: Subluxations, cervical spine instability

A standard cervical spine x-ray series captures anteroposterior, lateral, and odontoid views [19]. All five views are used to evaluate the intervertebral foramen [41]. Radiographs of the lateral cervical spine may show straightening or reversal of the normal lordotic curve, which can represent spasm, guarding, or splinting of muscles that stabilize the neck [41].

Cervical spine x-ray is indicated for any significant trauma, pain, or cervical spine-related dysfunction; to rule out fracture; or screen for stenosis in symptomatic patients [16; 41; 59].

EVIDENCE-BASED PRACTICE RECOMMENDATION

According to the American College of Radiology (ACR), in absence of red flag symptoms, imaging may not be required at the time of initial presentation and the results rarely alter therapy. However, radiographs are widely accessible and useful to diagnose spondylosis, degenerative disc disease, malalignment, or spinal canal stenosis. As such, the ACR states that cervical spine x-ray is usually appropriate for initial imaging of patients with new or increasing nontraumatic cervical or neck pain with no red flags.

(https://acsearch.acr.org/docs/69426/Narrative. Last accessed September 23, 2022.)

Level of Evidence: Expert Opinion/Consensus Statement

Magnetic Resonance Imaging (MRI)

Magnetic resonance imaging (MRI) is the imaging study of choice for most cervical spinal abnormalities. MRI can add important information about soft tissue injuries related to bony injuries seen on x-ray or computed tomography (CT) or disk or ligamentous injuries suggested by x-ray, CT, or clinical findings [109]. It can also distinguish hematoma from edema. MRI is highly accurate in identifying disk injury and ligament injuries [19; 110]. It is able to detect ligament disruption and subtle vertebral fracture, but is unreliable in depicting sources of cervical diskogenic pain because significant annular tears can escape MRI detection [16; 41].

Indications for cervical spine MRI at four to six week follow-up include [22; 41; 47]:

- Persistent arm pain, neurologic deficits, or clinical signs of nerve root compression
- Cervical radiculopathy signs and symptoms
- Cervical disk injuries with any neurologic decline
- Failure of axial neck pain to resolve as expected

Patients with progressive neurologic deficit should receive MRI without delay.

MRI is contraindicated in patients with certain implanted devices, but MRI scanners compatible with pacemakers are now available. Some patients have panic reactions during MRI from claustrophobia and require mild sedation [51; 103].

Computed Tomography (CT)

MRI is superior at imaging soft tissue abnormalities and potential neurologic compromise, while CT better delineates bony pathology by producing multiple 2- and 3-dimensional images of spinal segments [7]. CT alone has limited value in assessing cervical radiculopathy but is useful for visualizing degenerative spine and facet changes, spinal alignment, fractures, herniated disks, spinal and foraminal stenosis, and osteophyte formation, especially when not clearly shown on x-ray [23; 24; 50; 58; 103]. It is important to avoid unnecessary CT scanning to limit patient radiation exposure and associated carcinogenic risk [103].

CT Myelography

Myelogram followed by CT scan evaluates the spinal canal, its relationship to the spinal cord, and nerve root impingement from disk, spur, or foraminal encroachment. CT myelography is superior to MRI in detecting encroachment but is reserved for complex cases due to greater expense and morbidity or when MRI is unavailable, intolerable to the patient, or contraindicated [19; 51].

Provocative Cervical Diskography

Provocative cervical diskography is the only procedure that can identify a disk as the pain generator. In this test, contrast dye is injected into the nucleus pulposus to visualize disk architecture and provoke a pain response. Discomfort and invasiveness make this procedure less desirable than cervical MRI, which provides much of the anatomic information. Possible complications include diskitis, epidural abscess, quadriplegia, stroke, pneumothorax, and nerve and spinal cord injury [51].

MRI often misses significant tears, which diskography can reveal as diskogenic source of cervical pain. As noted, while MRI can identify most painful disks, it has relatively high error rates [41].

ASSESSMENT OF RISK LEVEL FOR CERVICAL SPINE INJURY
High Risk
One or more of the following factors: • Dangerous mechanism of injury • Age 65 years or older • Paresthesia in upper or lower limbs
Low Risk
Patients unable to rotate their neck 45° left and right and one or more of the following factors: • Involved in a minor rear-end motor vehicle accident • Comfortable in a sitting position • Ambulatory at any time since the injury • No midline cervical spine tenderness • Delayed onset of neck pain
No Risk
Patient has one low-risk factor and can rotate his/her neck 45° left and right.
Source: [111] *Table 4*

Electrodiagnostic Tests

Electromyography and nerve conduction studies are the standard for evaluating cervical spine neurologic function and have advantages of limited cost and morbidity [51]. With persistent radicular symptoms, electromyography can help identify injuries to cervical nerve roots, brachial plexus, or peripheral nerves [16]. It may show nerve injury missed by imaging studies that only show structural injury [41].

Electromyography shows abnormalities with high specificity in cervical radiculopathy, diagnosed when two muscles innervated from the same nerve root are abnormal. Multiple muscles should be examined, including the paraspinals [11; 12; 22]. Nerve conduction studies are useful when extremity pain rather than cervical pain is more severe [7].

Initial Imaging

Initial imaging is recommended for some patients when they first present for medical attention with neck pain or symptom complaints.

Acute Cervical Spine Injury

The Canadian C-spine Rule identifies patient risk of cervical spine injury and appropriate diagnostic imaging. "Dangerous mechanism of injury" is defined as falling from a height greater than 3 feet or axial load to the head from diving, high-speed or rollover motor vehicle accident, ejection from a motor vehicle, accident involving motorized recreational vehicles or horse riding, or bicycle collision [111]. The Canadian C-spine Rule assesses high, low, or no patient risk of cervical spine injury (***Table 4***). Importantly, neck movement is unsafe to assess in high-risk patients [109; 111].

Cervical spine x-rays are indicated for all high-risk and low-risk patients [19; 109; 111]. CT and/or MRI is recommended for patients with one or more high risk factors, or one or more low-risk factors and inability to rotate neck 45° left and right. The Congress of Neurological Surgeons recommends CT and MRI for cervical spinal injury in patients with cervical spondylitis, even after minor trauma [112; 113]. No-risk patients do not need imaging.

Other indications for cervical spine MRI include [103; 111]:

- Suspicion of cord compression
- Neurologic signs or symptoms, even if x-ray is negative
- Ligament or disk injuries suggested by x-ray, CT or clinical findings
- Suspected nerve root compression, disk herniation or cord contusion following neck injury
- Assessment of red-flag conditions

LABORATORY TESTING

Unless red flag conditions are suspected, laboratory tests are seldom needed in the evaluation of neck pain [103].

TREATMENT OF NECK PAIN

Practice guidelines for primary care are consistent in recommended management of acute neck pain [7; 102; 103; 107]. After red flag causes and radiculopathy are ruled out, the neck pain condition is given a nonspecific diagnosis. Patients should then be instructed to take over-the-counter analgesics (e.g., acetaminophen, nonsteroidal anti-inflammatory drugs [NSAIDs]) if needed and to avoid bed rest and maintain activity. Patients should also be reassured their neck pain is benign, time-limited, and has an excellent prognosis. If pain worsens at any time, clinicians should consider specialist referral. If pain persists three to six weeks later, a brief psychosocial assessment is performed to assess "yellow flags," and patients are referred to physical therapy.

This standard guidance has merits of simplicity for clinicians, the benefits of remaining active, and the spontaneous resolution of acute neck pain in some patients. However, some assumptions may be inaccurate, such as the benign, self-limiting nature of most neck pain and patient access to, or availability of, specialist pain providers. Several systemic barriers interfere with patient access to pain therapy, including [114; 115]:

- The acute nationwide shortage of pain specialist physicians
- The limited availability in some areas of trained physical, psychologic, or occupational therapy providers
- Insurance non-coverage of nonpharmacologic pain therapies, restrictive coverage that fragments and delays therapy continuity, and/or deductibles that are unaffordable

Poorly controlled acute pain can have negative consequences that include delayed recovery, disrupted sleep, and impaired physical and social functioning that diminishes the quality of life. Regardless of origin, poorly managed acute pain can transition to chronic pain [116]. Pain should be treated at once if it impairs functioning, and treatment options should be discussed clearly with the patient to prevent unrealistic expectations and possible disappointment [71].

The adverse impact of chronic pain on mortality captures the gravity of this state and importance to control. In one observational follow-up study, patients with noncancer chronic pain who attended an outpatient pain clinic from 2004–2012 were followed until May 2019. During a mean 10.4-year follow-up of 1,498 patients, 296 died. Of these, standardized mortality ratios among patients in the youngest age group (18 to 49 years of age) was significantly higher than that of the general population: 2.6 for men and 2.9 for women. Women 60 to 69 years of age had a mortality ratio of 2.3. Low baseline health-related quality of life and poor ratings in psychosocial dimensions were associated with an increased risk of death [117].

PATIENT EDUCATION

As noted, acute neck pain guidelines recommend that clinicians educate and reassure patients of the typically benign nature and self-limited course of nonspecific neck pain and the importance of maintaining activity and movement. Education and counseling may also include spine anatomy and proper postures, pain perception neuroscience, pain coping strategies, and resumption of normal activities. Education interventions may add small benefits to physiotherapy but should not be used alone due to ineffectiveness [8; 118].

EVIDENCE-BASED PRACTICE RECOMMENDATION

For patients with acute neck pain with movement coordination impairments (including WAD), the American Physical Therapy Association recommends clinicians provide the education of the patient to return to normal, non-provocative pre-accident activities as soon as possible; to minimize use of a cervical collar; and to perform postural and mobility exercises to decrease pain and increase range of motion. Patients should be reassured that recovery is expected to occur within the first two to three months. (https://www.jospt.org/doi/full/10.2519/jospt.2017.0302. Last accessed September 23, 2022.)

Strength of Recommendation/Level of Evidence: B (Moderate recommendation based on one or more level II systematic reviews or a preponderance of level III systematic reviews or studies support the recommendation, providing evidence for a mild-to-moderate magnitude of effect)

For patients who are not proficient in English, it is important that information regarding the etiology of their pain and pain management resources be provided in their native language, if possible. When there is an obvious disconnect in the communication process between the practitioner and patient due to the patient's lack of proficiency in the English language, an interpreter is required. Interpreters can be a valuable resource to help bridge the communication and cultural gap between patients and practitioners. Interpreters are more than passive agents who translate and transmit information back and forth from party to party. When they are enlisted and treated as part of the interdisciplinary clinical team, they serve as cultural brokers who ultimately enhance the clinical encounter. In any case in which information regarding treatment options and medication/treatment measures are being provided, the use of an interpreter should be considered. Print materials are also available in many languages, and these should be offered whenever necessary.

PHARMACOTHERAPIES

Standard practice guidelines recommend the following analgesic options for acute/subacute neck pain [7; 102; 103; 107]:

- Acetaminophen
- NSAIDs
- Muscle relaxants
- Opioid analgesics

Chronic neck pain management is more difficult and complex, but pharmacotherapy guidelines for chronic neck pain are non-existent, and general guidelines for the management of chronic pain may be unhelpful.

Practice guidelines recommend drug and non-drug therapies based on randomized controlled trials, considered the best study design to detect efficacy. Analgesic randomized controlled trials are usually placebo-controlled. Systematic reviews examine treatment efficacy by pooling the results of randomized controlled trials to measure differences in average response to treatment versus comparator/placebo [119].

Systematic reviews of guideline-recommended analgesics for neck pain have found acetaminophen ineffective and NSAIDs minimally effective, compared with placebo. Systematic reviews have also found minimal benefit in other analgesics considered effective. These results may reflect true ineffectiveness or possible limitations with randomized controlled trial evaluation of analgesics, including [120; 121]:

- Rigid protocols that disallow dose adjustments when ineffective or intolerable
- Strict enrollment criteria, with outcomes of research subjects dissimilar to typical patients
- Increasing placebo-response rates that require larger studies to show relevant differences from placebo

In some cases, it is not the study design but the paradigm itself that limits usefulness. Randomized controlled trials have evaluated analgesic efficacy in patients with specific pathologies (e.g., disk herniation, degenerative processes). The efficacy of oral analgesics is mostly unrelated to underlying tissue pathology, which can produce diverse pain mechanisms. Pain mechanism targeting is now emphasized [69; 70].

Central sensitization is recognized to underlie many chronic neck pain cases and is very difficult to treat. Optimized pain reduction can require combining medications that target peripheral inputs in the dorsal horn (bottom-up) and descending pain modulation pathways (top-down) with tapentadol (opioid and norepinephrine reuptake inhibitor) or opioids plus NSAIDs, norepinephrine reuptake inhibitors, or anticonvulsants. Adding topical analgesics can help decrease peripheral nociceptive input [69; 96; 122; 123]. A 2017 practice guideline recommended combining analgesics in chronic pain treatment [124].

Assessment of Analgesic Response

Assessing treatment response to neck pain pharmacotherapy is very important. This requires the patient reaching and maintaining adherence to a target dose at which therapeutic effect is expected for at least two weeks. The most common errors are underdosing and insufficient treatment duration [71].

Assess treatment response using a 0–10 scale, and use the results to help guide treatment planning [71]. With a pain reduction to <3, continue monotherapy and consider indication for combination therapy, when appropriate. For a pain reduction by ≥30% but a pain intensity ≥4, combine the existing therapy with an additional first-line drug. If pain is reduced by <30% and the pain intensity ≥4, the drug should be considered ineffective and the patient should be switched to another first-line agent.

It is also important to check for side effects [71]. If intolerable side effects prevent effective dosing, switch to another drug. If the patient is taking a clinically effective dose but intolerable side effects continue, lower the dose before switching analgesics. Depending on the therapeutic and side effects after this is done, try switching the drug or starting combination therapy with a low dose of the original drug. If the pain relief remains inadequate, consult a pain specialist or refer the patient to a pain center.

Acetaminophen

Acetaminophen (paracetamol) is a nonsalicylate antipyretic analgesic recommended as first-line therapy in mild-to-moderate acute or chronic low back, spinal, and musculoskeletal pain [125; 126; 127]. Enduring assumptions of its efficacy and safety were first challenged by a randomized controlled trial of 1,649 patients with acute low back pain. Following 28 days of acetaminophen or placebo taken as regular dosing (three times per day) or as needed for pain, acetaminophen did not differ from placebo on any pain outcome, average time to recovery, or tablets consumed per day [126].

Reviews of placebo-controlled trials concluded that acetaminophen was ineffective in reducing pain and disability in low back pain and showed little evidence of efficacy in diverse chronic pain conditions. Even 4,000 mg/day for 1 to 12 weeks had no effect beyond placebo on pain, quality of life, function, or sleep quality in acute low back pain, and any effect in chronic low back pain was uncertain [125; 127; 128]. A caveat is that very few studies have evaluated acetaminophen in neck pain.

Acetaminophen shows a significant dose-response effect for increased risks of cardiovascular, renal, and GI adverse effects, suggesting considerable toxicity risk, especially at the upper end of standard analgesic dosing [129]. Acetaminophen may cause liver failure in acute overdose or chronic excessive exposure [130]. The universal endorsement and routine use of acetaminophen as first-choice analgesic in acute and chronic neck pain is questioned [125; 126; 127].

Muscle Relaxants

Appropriate for muscle spasm with pain, there is strong evidence that muscle relaxants can provide short-term pain relief in acute low back pain (and by extension, neck pain due to spasm). Clinicians should consider the side effects of drowsiness or dizziness. Carisoprodol is not recommended because its active metabolite, meprobamate, is a drug with abuse potential [103].

NSAIDs

NSAIDs are endorsed universally as first-line therapy for acute mild-to-moderate pain of any origin and broadly as first-line therapy for diverse chronic pain conditions, including neck pain. NSAIDs have similar pharmacology but diverse molecular structure. Patient response to specific NSAIDs varies, and several trials of different NSAIDs may be needed to identify an effective agent [103].

A meta-analysis evaluated 35 randomized controlled trials for NSAID efficacy in low back, neck, and sciatica pain. Pain and disability outcomes of NSAIDs or placebo were pooled and averaged, and differences were compared using a 0–10 scale. No study reported outcomes beyond 12 weeks. Only two neck pain studies were found, and the outcomes of these studies were for less than four weeks [131].

NSAIDs surpassed placebo in neck pain reduction by 1.6, a minimally important difference to patients in pain. NSAIDs surpassed placebo by 1.2 in disability reduction. Average differences between NSAIDs and placebo in low back pain/sciatica were lower than neck pain. In aggregate, six participants required treatment with NSAIDs, instead of placebo, for one additional participant to achieve clinically important pain reduction [131].

Another review of NSAIDs in spine pain found two neck pain studies. One involved intravenous NSAIDs, but the other study found greater pain reduction with indomethacin and piroxicam over placebo, and no difference between NSAIDs [47].

NSAIDs inhibit cyclooxygenase-1 and -2 (COX-1 and COX-2), enzymes that convert arachidonic acid to pro-inflammatory prostanoids. COX-2 inhibition reduces inflammation and pain. Prostanoids also play key roles in maintaining normal physiologic processes; their inhibition accounts for the adverse effects of NSAIDs [132; 133].

COX-1 inhibition suppresses prostaglandins that protect the gastric mucosa and thromboxanes that promote platelet aggregation. COX-2 inhibition suppresses prostacyclins in vascular endothelium that inhibit platelet aggregation [134]. Thus, serious or fatal GI, cardiovascular, or renal adverse effects can result from NSAIDs use [133].

In 1997, 16,500 deaths from upper GI bleeding/perforation were linked to NSAIDs [135; 136]. This prompted introduction of COX-2-selective NSAIDs to reduce GI risks, which became linked to cardiovascular adverse effects. The view emerged that COX-2 selective NSAIDs had greater risk of cardiovascular toxicity and lower risk of GI toxicity than traditional NSAIDs. Greater accrual of patient outcomes demonstrated all NSAIDs carry GI and cardiovascular risks [132; 137; 138; 139].

Celecoxib has the least GI toxicity but high, dose-related cardiovascular risk. Naproxen has the best cardiovascular safety, but greatest GI toxicity [139]. Concurrent NSAID and selective serotonin reuptake inhibitor (SSRI) use increases upper GI bleeding risks [140; 141]. Adding a proton pump inhibitor or switching NSAIDs to celecoxib is recommended to mitigate upper GI risks [142]. Despite greater awareness, NSAIDs cause 7,000 to 10,000 GI hemorrhage fatalities annually [143].

All NSAIDs increase risks of fatal and non-fatal cardiovascular and cerebrovascular events and renal failure, especially in elderly patients. Serious adverse effects can occur within one month of regular therapy. Long-term NSAID use is not recommended, and NSAIDs should be used at the lowest effective dose for the shortest duration possible [103; 134; 144]. Given the risk profile, clinicians should reconsider using NSAIDs for pain and limit their use to pain with inflammation [145].

Antidepressants

Noradrenergic projections form a key component of descending pain inhibition pathways. Impaired descending pain inhibition can facilitate and maintain chronic pain. Drugs that inhibit norepinephrine reuptake can enhance spinal noradrenergic efficiency to reduce chronic pain, including some antidepressants and the opioids tramadol and tapentadol [69; 123].

Tricyclic antidepressants (TCAs) and selective serotonin/norepinephrine reuptake inhibitors (SNRIs) are recommended first-line options in chronic neuropathic pain disorders and in chronic pain with a neuropathic component [67; 69; 71].

Tricyclic Antidepressants

The first antidepressants used in pain treatment, TCAs may also produce analgesia by blocking NMDA-induced hyperalgesia, voltage-gated sodium channels, and delta-opioid receptor interaction [146; 147; 148]. Amitriptyline is the most studied, endorsed, and prescribed TCA in chronic pain, and some evidence suggests it may be the most effective analgesic antidepressant [68; 70; 71; 79]. Other TCAs (e.g., nortriptyline, desipramine) are better tolerated but lack the evidence base of amitriptyline. Analgesic effects are independent of antidepressant effect, and analgesic dosing is 20% to 33% of antidepressant doses [148].

SNRIs

Duloxetine and venlafaxine are the most-studied SNRIs in chronic pain, with duloxetine the most widely endorsed agent [79]. SNRIs inhibit reuptake of serotonin and norepinephrine, but norepinephrine activity accounts for analgesic effects. In contrast, SSRI antidepressants have negligible norepinephrine activity and minimal analgesic efficacy.

Unlike TCAs, SNRIs require antidepressant doses for analgesia, especially venlafaxine, which only inhibits serotonin reuptake at lower doses (<200 mg/day) [148]. Duloxetine 60–120 mg/day is used for pain, with doses <60 mg/day ineffective [71].

Several placebo-controlled trials have evaluated duloxetine in chronic low back pain without radiculopathy or stenosis. Outcomes from four of these studies were pooled; 12 to 14 weeks of duloxetine led to pain reduction ≥30% in 60% (versus 48% with placebo) and ≥50% in 49% (versus 35% with placebo). Analgesic response to duloxetine surpassed placebo by 13% on both pain outcomes [149].

Another study of different doses found duloxetine 20 mg, 60 mg, and 120 mg no different from placebo at week 13, and noted a 24% dropout rate from side effects with duloxetine 120 mg [150]. Duloxetine doses higher than 60 mg daily have not consistently shown benefit in clinical trials [148].

With duloxetine in chronic pain, analgesic effects accounted for 91% of pain reduction in patients screened for depression, which shifted over time to antidepressant effects in patients with comorbid depression. The authors noted the mutually reinforcing relationship between pain and depression makes it plausible that alleviating depression can reduce pain symptoms [151].

Duloxetine was less effective in isolated chronic low back pain than in patients with two or more painful sites. Multiple pain sites may better reflect CNS alterations that amplify pain perception, and suggest duloxetine is more effective in centralized chronic pain [149].

Milnacipran, another SNRI, after six weeks was no different from placebo in pain reduction in chronic low back pain with a neuropathic component [152].

Antidepressant Adverse Effects

TCA side effects are intolerable for some patients, and low-dose (10 mg/day) initiation with gradual increase to 75 mg/day is suggested [71]. TCAs should be used cautiously in elderly patients due to greater risks of postural hypotension, impaired cognition, and falls and should be avoided in patients with a history of cardiovascular disease [68; 148].

In placebo-controlled pain studies, desipramine and venlafaxine had the highest overall rates of adverse effects. Desipramine, milnacipran, venlafaxine, and duloxetine had highest dropout from side effects, suggesting greater severity and unpleasant perception. Adverse effects associated with duloxetine (e.g., nausea, constipation, dry mouth, hyperhidrosis) differed somewhat from amitriptyline (e.g., dry mouth, thirst, constipation, headache, weight gain, blurred vision, palpitations) [153].

Antiepileptic Drugs

Antiepileptic drugs are diverse, but pregabalin and gabapentin are the only widely studied agents in chronic low back pain. As with antidepressants, few neck pain studies are available and chronic low back pain outcomes are used to inform decisions.

Pregabalin and gabapentin are widely recommended first-line agents in neuropathic pain disorders, such as painful diabetic neuropathies and postherpetic neuralgia [70]. Analgesic, anxiolytic, and anticonvulsant effects arise from binding to alpha-2/delta-1 subunits of calcium channels, highly expressed in brainstem structures where descending pain modulatory pathways originate and a likely key analgesic target of pregabalin/gabapentin [68].

Pregabalin has greater binding affinity and greater analgesic potency in neuropathic pain than gabapentin. Pregabalin also has more rapid absorption, greater bioavailability, and a linear dose-response [68].

The dosage of pregabalin in pain treatment is 300 – 600 mg/day in divided doses. Gabapentin is used at 1,200 – 3,600 mg/day in three divided doses. Both can be initiated at 10% the maximum dose, increased every three to four days [71]. Pregabalin 600 mg/day has greater efficacy than 300 mg/day [70].

Pregabalin/gabapentin is generally well tolerated. The adverse effects most common with pregabalin are dizziness, somnolence, dry mouth, edema, and blurred vision; with gabapentin, common adverse effects include dizziness and somnolence (>20% of patients), confusion, and peripheral edema [68].

Adverse effects increase with pregabalin dose but do not appear to be age-related. In patients 65 years of age and older, titration to the lowest effective dose may help minimize adverse effects. Absence of known drug interactions with pregabalin/gabapentin increases safety in patients requiring polypharmacy [154].

Gabapentinoid efficacy in chronic spine-related pain is inconsistent. An uncontrolled study compared pregabalin monotherapy, pregabalin add-on therapy, and non-pregabalin therapy under "real-world" primary care conditions in 1,351 patients with chronic painful cervical (13%) or lumbosacral (87%) radiculopathy [155]. Pregabalin groups received 190 mg/day (mean). At 12 weeks, pain intensity reduction ≥50% was attained by 63%, 56%, and 33% of patients in pregabalin, pregabalin add-on, and non-pregabalin groups, respectively. Differences in pain reduction were significant by week 4. Improvements in sleep disturbances, depression, anxiety, and quality of life showed large effect sizes in pregabalin groups and moderate effect sizes in the non-pregabalin group [155]. The authors noted non-pregabalin patients received NSAIDs (67%) or acetaminophen (37%) rather than tramadol (19%), gabapentin (13%), or amitriptyline (5%), indicating

inappropriate treatment with NSAIDs and acetaminophen, which are ineffective in chronic pain with a neuropathic component [155].

In contrast to these uncontrolled results, a review of pregabalin/gabapentin studies in nonspecific chronic low back pain found minimal pain improvement with gabapentin compared with placebo, and pregabalin inferior to active-drug control groups (with buprenorphine, tapentadol, or celecoxib). Studies comparing pregabalin to placebo were not found [156].

In a small trial, patients with chronic cervical or lumbar radicular pain had greater pain reduction with placebo than pregabalin after three weeks [157]. Pregabalin plus tapentadol did not improve tapentadol efficacy in severe chronic low back pain with a neuropathic component and significantly increased dizziness and somnolence [158].

An uncontrolled trial of pregabalin in cervical spondylosis pain found significant pain reduction after eight weeks, but intolerable somnolence and dropout by 27 of 50 patients. The authors suggest greater sensitivity to this side effect in the Asian study population [159].

Importantly, drug users who combine heroin (and possibly some patients receiving opioid therapy) with gabapentin or pregabalin potentially increase their risk of acute overdose death by reversing opioid tolerance or through additive effects on respiratory depression [160].

Opioid Analgesics

When severe pain requires powerful analgesic control, few options are as effective and widely available as opioids [161]. Non-opioid analgesics were examined for chronic pain efficacy in 271 randomized controlled trials. Many showed statistically significant effect sizes, but pain reduction sizes were usually not clinically relevant [162]. However, the current regulatory environment and concern regarding misuse inhibits opioid prescribing, placing clinicians with patients in severe pain in a double-bind [163].

Opioid prescribing is a complex issue that should be approached by balancing control (to prevent inappropriate use) with access (for appropriate patients). With focus on either, and neglect of the other, consequences follow [164]. Overemphasis on access has led to increased opioid prescriptions and related addiction, diversion, and overdose deaths. Retail opioid prescriptions peaked in 2010 and by 2018 (168 million) were below population-adjusted levels for 2000 (172 million) and 1999 (161 million) [165; 265]. Prescription opioid analgesic use per capita (in MME) fell 62.3% from 2011 to 2020 [266]. Prescription opioid analgesic presence in drug overdose deaths rose to 11,693 in 2011, increased in 2016 (14,487) and 2017 (14,495), and decreased to 13,131 in 2021 [267; 268].

Until improved analgesics are developed, opioids remain the only option for severe pain in many patients [161]. Clear evidence demonstrates that screening for substance use disorder before initiating opioid therapy in patients with chronic pain minimizes its development [96; 166; 167; 168]. In addition, most fatalities involving prescription opioid analgesics occur with co-ingested benzodiazepines, alcohol, and other CNS/respiratory depressants. Prevention involves patient education and cautious or avoidance of co-prescribing CNS depressants [169; 170; 171].

In controlling severe acute neck pain, oxycodone, morphine, and hydromorphone are similarly effective. For chronic moderate-to-severe neck pain, the suggested options shift to several more recent opioid preparations with lower abuse potential, greater tolerability, and/or alternate drug delivery that increase safety in long-term use.

Opioid-induced constipation is a class-wide opioid adverse effect perceived by patients as the most distressing side effect [172]. A study of chronic pain patients with opioid-induced constipation from prior opioids found patient fear of constipation led to a number taking little or no study medication and inadequate pain control, despite the study drug being designed to reduce opioid-induced constipation [173].

IDENTIFYING ADDICTION IN PATIENTS PRESCRIBED OPIOIDS
When implementing a neck pain treatment plan that involves the use of opioids, the patient should be frequently reassessed for changes in pain origin, health, and function. Signs and symptoms that, if present, may suggest a problematic response to the opioid and interference with the goal of functional improvement include: • Excessive sleeping or days and nights turned around • Diminished appetite • Short attention span or inability to concentrate • Mood volatility, especially irritability • Lack of involvement with others • Impaired functioning due to drug effects • Use of the opioid to regress instead of re-engaging in life • Lack of attention to hygiene and appearance
Information obtained by patient history, physical examination, and interview, from family members, a spouse, or state prescription drug monitoring database, and from the use of screening and assessment tools can help the clinician to stratify the patient according to level of risk for developing problematic opioid behavioral responses. A urine drug test should be performed prior to initiating opioid treatment.
Low-risk patients receive the standard level of monitoring, vigilance, and care. Moderate-risk patients should be considered for an additional level of monitoring and provider contact, and high-risk patients are likely to require intensive and structured monitoring and follow-up contact, additional consultation with psychiatric and addiction medicine specialists, and limited supplies of short-acting opioid formulations.
If substance abuse is active, in remission, or in the patient's history, one should consult an addiction specialist before starting opioids. In the setting of active substance abuse, opioids should not be prescribed until the patient is engaged in treatment/recovery program or other arrangement made, such as addiction professional co-management and additional monitoring. When considering an opioid analgesic (particularly those that are extended-release or long-acting), one must always weigh the benefits against the risks of overdose, abuse, addiction, physical dependence and tolerance, adverse drug interactions, and accidental exposure by children.
Screening and assessment tools can help guide patient stratification according to risk level and inform the appropriate degree of structure and monitoring in the treatment plan. It should be noted that despite widespread endorsement of screening tool use to help determine patient risk level, most tools have not been extensively evaluated, validated, or compared to each other.
Source: [176; 177; 178; 179; 180; 181] *Table 5*

Unlike other opioid side effects, opioid-induced constipation does not typically resolve with continued use, becoming chronic in 40% to 45% of patients on long-term opioids and adversely affecting patient quality of life and pain control [96; 172]. Opioid-induced constipation should be anticipated and managed prophylactically. Several medications are approved by the U.S. Food and Drug Administration (FDA) for opioid-induced constipation, including naloxegol, methylnaltrexone, lubiprostone, and naldemedine.

Abuse-Deterrent Formulations

All extended-release oral opioids are available in abuse-deterrent formulations, designed to make nontherapeutic use more difficult, less attractive, or less rewarding. Abuse-deterrent formulations use physical barriers that resist crushing; chemical barriers that form into a viscous gel if mixed with liquid; and/or opioid antagonist sequestration that product tampering activates to neutralize the agonist. Some abuse-deterrent formulations use multiple deterrence mechanisms. While abuse-deterrent formulations can deter extended-release opioid tampering to defeat the slow-release mechanism for a rapid-onset, high-dose opioid effect, they cannot prevent abuse of intact pills. Abuse-deterrent formulations are

one of several approaches to minimize prescription opioid abuse (***Table 5***), but insurance non-coverage is common, due to higher costs than standard opioid formulations [96; 174; 175].

Oxycodone/Naloxone

To reduce opioid-induced constipation during long-term therapy, the opioid antagonist naloxone was combined with oxycodone extended-release in a fixed-dose 2:1 ratio. Unlike short-acting naloxone, the extended-release formulation limits systemic exposure and does not block or reverse oxycodone analgesia [182]. Combination oxycodone/naloxone (Targin) was FDA-approved in 2014 but has since been discontinued for use in the United States [172; 183; 184]. Oxycodone/naloxone and oxycodone extended-release show similar efficacy in chronic pain. Oxycodone/naloxone reduces but does not eliminate constipation and seems more effective in new patients with opioid-induced constipation than in preventing constipation during treatment [182].

Buprenorphine

Buprenorphine differs from standard opioids as a partial mu-opioid receptor agonist. This produces a respiratory depression ceiling effect, making buprenorphine safer in overdose, and a euphoria ceiling effect that lowers drug "liking." Buprenorphine is a kappa-opioid receptor antagonist, producing an anti-hyperalgesic effect relevant to neuropathic pain that often contributes to chronic spine-related pain [185; 186; 187]. Transdermal buprenorphine is the primary form used in chronic pain treatment. The transdermal patch is effective for seven days, after which it is replaced [188]. A buccal formulation was FDA-approved in 2016 based on studies demonstrating efficacy in patients with moderate-to-severe chronic low back pain [189].

The lower abuse potential of transdermal buprenorphine also reflects its slow onset rate and difficulty extracting buprenorphine from the patch. Compared with fentanyl patches, extended-release opioids, and extended-release tramadol, transdermal buprenorphine has shown the lowest rates of abuse and diversion. Common side effects are constipation, dry mouth, nausea, vomiting, headache, dizziness, somnolence, and application site skin irritations [185; 186; 188].

In a study of transdermal buprenorphine therapy of 465 patients (median age: 67 years) with diverse chronic pain conditions, transdermal buprenorphine pain relief was rated effective/very effective by 69% after 3 months and 91% after at least 36 months [186]. Patient satisfaction with transdermal buprenorphine showed the same temporal pattern. Non-prescribed dose escalation (3%) was low, but patient motive (e.g., pain control, euphoria) was not analyzed. Dropout from ineffectiveness (4%) or adverse effects (12%, mostly skin irritation) exceeding similar trials [186].

Tramadol

Tramadol is a weak opioid that also inhibits serotonin and noradrenaline reuptake, and it is an established option in chronic low back pain. Opioid and non-opioid mechanisms both act to produce analgesia, and account for its low "likeability" by drug misusers, with lower abuse potential than other opioids. It may also have anti-inflammatory activity. Tramadol use with other serotonergic medications (e.g., most antidepressants) may result in serotonin syndrome and should be avoided [71; 96; 158].

Tapentadol

Tapentadol is a mu-opioid receptor agonist and norepinephrine reuptake inhibitor combined in a single molecule. Tapentadol extended-release was extensively investigated in Europe, with the finding that the formulation is effective in diverse chronic pain, with or without neuropathic pain component, in evaluations up to two years [190; 191]. Researchers found function, health status, and quality of life improved during long-term treatment. The drug has a good safety profile, with GI tolerability more favorable than other opioids and a low risk of withdrawal after cessation. To date, analgesic tolerance has not been found in long-term data.

In studies, tapentadol was as effective as oxycodone in nociceptive and neuropathic chronic low back pain, with better GI tolerability and treatment adherence [71; 192; 193; 194]. Earlier gains in function, health status, and quality of life maintained over one year in 1,154 patients receiving open-label tapentadol extended-release after completing randomized controlled trials, including average pain scores (3.9 start, 3.7 end) [195].

As noted, few studies have evaluated opioid therapy, and pharmacotherapy in general, in chronic neck pain. However, an uncontrolled trial evaluated tapentadol extended-release in 54 patients with moderate-to-severe chronic neck pain over 12 weeks [4]. Participants' reported pain-intensity scores (on 0–10 scale) were 1.7 resting (versus 6.8 at baseline) and 2.9 with movement (versus 8.8 at baseline). Approximately 89% of patients experienced ≥ 30% reduction in pain intensity on movement; 68% reported a ≥ 50% reduction. In addition, the average NDI score decreased from 55.6 at baseline to 19.7 after 12 weeks. Quality of sleep improved ≥ 30% in 79% of patients. Cervical range of motion was evaluated on flexion, extension, right and left lateral flexion, and rotation. Compared with baseline, patients with normal range of motion on flexion increased 13%; the other five measures increased 23% to 35% [4].

No patient dropped out from side effects, despite 90% being opioid-naïve on study entry. The average final dose was 204 mg/day, and tapentadol extended-release was well-tolerated in patients requiring 400 mg/day. Common side effects at 12 weeks were constipation and dizziness [4].

With further subject accrual, a second paper from this study compared tapentadol extended-release response in 94 patients with or without a neuropathic neck pain component. Both groups showed comparable reductions in neck pain intensity ≥30% (69% versus 70%) and in average pain scores from baseline (4.4 versus 4.8) at 4 weeks, and reduction in NDI scores from baseline to 12 weeks (46 to 13 versus 58 to 18) [196].

Despite the limitations of uncontrolled trials, this data, together with studies in chronic low back pain, suggest tapentadol extended-release may be effective and tolerable for patients with chronic moderate-to-severe neck pain.

The mu-opioid receptor binding affinity of tapentadol is 18-fold lower than morphine, suggesting lower abuse potential than standard opioids (confirmed by several studies) [96; 197]. In 113,914 individuals assessed for substance abuse treatment, tapentadol abuse was lowest overall and significantly lower than other prescribed oral opioids. Adjusted for nationwide prescription volume, tapentadol abuse liability was the second lowest, after only tramadol [198]. Among 1.9 million messages posted by recreational drug users on online forums, the proportion of discussions and endorsements for abuse were substantially lower for tapentadol than comparator drugs [199].

Data from drug diversion databases and investigators and anonymous street drug pricing websites indicate illicit sales and use of tapentadol extended-release was rare. In the few cases of illicit sales, tapentadol extended-release was 10% the price of standard opioids [200].

Cebranopadol and NKTR-181

Two novel opioid analgesics designed to improve safety over standard opioids are in pre-approval evaluation. Cebranopadol is a mu-opioid receptor agonist and nociceptin/orphanin FQ peptide receptor agonist that may improve respiratory depression safety. A 14-week study in chronic low back pain found cebranopadol comparable to tapentadol in analgesic efficacy and sleep and functional improvements [201].

Oxycodegol (NKTR-181) is a long-acting mu-opioid receptor agonist with structural properties that alter its brain-entry kinetics and may limit abuse potential [174]. Initial studies involving patients with chronic low back pain have found improvements in pain score and sleep compared with placebo [202]. In January 2020, the FDA rejected approval for the new drug application for oxycodegol, raising concerns about the drug's potential for misuse or abuse [203; 204].

Topical Analgesics

Transdermal analgesic formulations are used for systemic drug delivery, absorption, and distribution. In contrast, topical analgesics are used for drug delivery to local tissue while avoiding systemic exposure.

Topical analgesics have evolved to gain acceptance as analgesic options and have the potential to reduce pain in some conditions while avoiding the side effects of systemic analgesics. Topical analgesics include FDA-approved and compounded formulations.

FDA-Approved Topical Analgesics

FDA-approved topical analgesics include NSAID gel or cream, 5% lidocaine patch or plaster, and 8% capsaicin patch [205].

Topical NSAIDs are increasingly favored in musculoskeletal conditions to avoid the systemic adverse effects of oral NSAIDs, with diclofenac and ketoprofen the most-studied topical NSAIDs. In acute pain, benefit in sprains or strains has good evidence, but the formulation used is critically important; this same consideration may also apply to chronic conditions. Use in chronic musculoskeletal conditions assessed over 6 to 12 weeks showed good pain relief beyond inert carrier in a minority of patients with knee osteoarthritis, limited benefit in hand osteoarthritis, and no evidence in other chronic painful conditions [206; 207].

Emerging data suggest the capsaicin 8% patch and lidocaine 5% patch or medicated plaster may both be effective in the treatment of chronic low back pain (and by extension, chronic neck pain) with a neuropathic component [71]. Sodium channels expressed on nerve fibers become altered in neuropathic pain to enhance excitatory neurotransmission [69]. Lidocaine prevents the generation of pathologic nerve excitation by blocking sodium channels. Topical lidocaine may be beneficial when neuropathic pain is localized, because the maximum penetration depth is 8–10 mm. Lidocaine patches are applied to the painful area for 12 hours, followed by a patch-free interval of 12 hours [68].

An uncontrolled study evaluated 5% lidocaine plaster in 23 patients with cervical or lumbar disk herniation and peripheral neuropathic pain (radiculopathy). Compared with baseline, mean pain intensity scores following average treatment duration of eight months decreased from 8.3 to 3.1. Treatment was well-tolerated [208].

In neuropathic pain, transient receptor potential (TRP) channels induce and maintain spontaneous pain and thermal hyperalgesia. The TRPV1 agonist capsaicin activates TRP channels, and desensitization that follows can reduce neuropathic pain [70; 71]. Capsaicin 8% patch was effective in painful radiculopathy when placed on involved spinal nerve dermatomes. Fifty patients with cervical or lumbar radiculopathy were evaluated 12 weeks after a single treatment. Among patients with pain duration 3 months, 24 months, or >24 months, 50%, 71%, and 39% achieved ≥30% pain reduction, respectively. Four patients experienced application site pain or pruritus [209].

Compounded Analgesic Formulations

Analgesic medications compounded for topical use are gaining popularity in chronic pain management. Compounded analgesic formulations have the potential advantages of FDA-approved topical analgesics, but with a broader range of options, including ketamine, clonidine, gabapentin, baclofen, and phenytoin [205]. Compounded analgesic formulations typically combine three or more analgesic drugs to achieve multiple complementary effects at lower doses of each drug [210].

Some evidence suggests greater pain reduction with compounded versus FDA-approved topical analgesics. In an uncontrolled study, 2,177 patients with chronic pain received one of three treatments [211]:

- Cream I: Flurbiprofen (20%), tramadol (5%), clonidine (0.2%), cyclobenzaprine (4%), and bupivacaine (3%)
- Cream II: Flurbiprofen (20%), baclofen (2%), clonidine (0.2%), gabapentin (10%), and lidocaine (5%)
- Voltaren gel: 1% diclofenac sodium (an FDA-approved NSAID formulation)

Pre-treatment chronic extremity, joint, musculoskeletal, or neuropathic pain intensity (0 – 10 scale) in all groups was severe (range: 7.9 – 8.4). Post-treatment pain intensity scores decreased 37% with cream I, 35% with cream II, and 19% with Voltaren gel. The compounded analgesic formulations did not differ in efficacy, and both were superior to Voltaren [211].

Many small uncontrolled trials show compounded analgesic formulations' efficacy, but this approach must balance local penetration against systemic exposure and potential toxicity. Compounding is not FDA-regulated; vehicle formulation and active drug concentration should be standardized for greater confidence in compounded analgesic formulations safety and efficacy [212].

Cannabinoids

Cannabinoids, which include plant *Cannabis*, cannabidiol extracts, and pharmaceutically synthesized molecular constituents of *Cannabis*, are increasingly available to patients with pain through state-level enactment of medical access. Cannabinoids are seldom considered first-choice therapeutic options but are used instead in patients for whom standard therapies are ineffective or intolerable, either as sole therapy or more typically as an add-on to the current regimen [213]. Cannabis has been safely co-administered with a wide range of other drug agents and acts synergistically with opioids to enhance analgesia and allow opioid dose reduction. Chronic pain treatment often requires multiple drug agents that target different pain mechanisms, and the novel mechanism and superior safety profile of cannabis versus opioids suggests that it can be a valuable addition to therapeutic options for chronic pain [214; 215; 216].

PHYSIOTHERAPIES

Physiotherapies broadly encompass passive interventions (i.e., without patient exertion or effort), such as massage and manipulation, and active interventions (i.e., requires patient exertion and effort), such as physical and exercise therapy. They are delivered by trained and licensed allied healthcare professionals manually to affected soft tissue or joints, or through instruction and supervision with active interventions. Physiotherapies may also include mechanical devices that patients with positive results can purchase for continued use at home but must be prescribed by their physician [41].

Soft Tissue Therapies

Massage

Massage therapy involves manual manipulation of soft tissue structures. Clinical (therapeutic) massage aims to accomplish specific goals, such as releasing muscle spasms. An example is myofascial trigger point therapy. Relaxation massage aims to relax muscles, move body fluids, and promote wellness [8].

Indications for massage include edema, muscle spasm, adhesions, and the need to improve peripheral circulation and range of motion or to increase muscle relaxation and flexibility prior to exercise. Massage can produce immediate pain reduction, and a frequency of one to two times per week for six to eight weeks is suggested [103]. Massage therapy (once-weekly for 10 weeks) can provide short-term relief for chronic cervical myofascial pain and reduce pain-related impairments [57].

A practice guideline concluded therapeutic massage can decrease pain and tenderness and improve range of motion in patients with subacute or chronic neck pain. Massage interventions are effective for relieving neck pain symptoms at post-treatment, but data on long-term effects are insufficient [217].

Soft Tissue Mobilization

Mobilization of soft tissue applies muscle energy, strain/counter strain, myofascial release, manual trigger point release, and other manual therapy techniques to improve or normalize movement patterns by reducing soft tissue pain and restrictions [103]. Mobilization applies gentle pressure within or at the limits of normal motion with the goal of increasing cervical range of motion [65].

Indications include muscle spasm around a joint, trigger points, adhesions, and neural compression. Mobilization should be accompanied by active therapy. The usual course of treatment is up to three times per week for four to six weeks [103].

Myofascial Release Therapy

In myofascial release therapy, after myofascial tissue with pain-generating trigger points is identified, focused manual pressure and stretching is applied to loosen restricted muscle and joint movements and reduce pain.

Pressure pain threshold is a validated measure of mechanical hyperalgesia and accurately discriminates chronic neck pain with neuropathic features from that without. Using an algometer (hand-held device), tissue pressure is increased until pain is evoked (the pressure pain threshold) [218].

Myofascial release therapy was compared with physical therapy for efficacy in reducing pressure pain threshold and neck pain in 41 patients randomized to myofascial release therapy (5 sessions) or multimodal physical therapy (10 sessions of ultrasound therapy, transcutaneous electrical nerve stimulation [TENS], and massage) over two weeks. At one-month follow-up, significant mean differences were found in pain scores and pressure pain threshold (trapezius, suboccipital) favoring myofascial release therapy. Better short-term improvement in neck pain with myofascial release therapy over physical therapy is suggested [218].

Joint-Directed Therapies

Joint-directed therapies include manipulation and joint mobilization. Spinal manipulation and mobilization may restore normal range of motion and decrease pain. The therapeutic mechanisms remain unknown, but facet joint adjustment may normalize afferent signaling from mechanoreceptors to the CNS, which may improve muscle tone, decrease muscle guarding, promote effective local tissue metabolism, and lead to pain and range of motion improvements [51].

Manipulation

Manipulative treatment applies manually guided force to reduce pain and improve physiologic function [103]. Manipulation is a broad term that includes high-velocity, low-amplitude thrusts to the cervical spine, and modalities such as myofascial release, counterstrain, and/or indirect or direct muscle energy techniques. Non-high-velocity, low-amplitude techniques may also be referred to as mobilization [16].

The most common chiropractic spinal manipulation is high-velocity, low-amplitude thrust to spinal segments, applied at or near the end of a joint's passive range of motion to increase articular mobility or realign the spine. Manual manipulation is also performed by osteopathic physicians trained in manipulative medicine [219].

Some evidence supports chiropractic treatment of WAD [16]. A 2015 Cochrane review of multiple manipulation treatment sessions in neck pain concluded combining laser therapy with manipulation may be superior to manipulation or laser alone for acute and chronic neck pain [220]. For acute and subacute neck pain, manipulation was more effective than muscle relaxants, NSAIDs, and acetaminophen in improving pain and function at immediate (same day) and long-term (around one year) follow-up, and function at intermediate (around six months) follow-up. For patients with acute neck pain, manipulation may be more effective in improving pain and function at short (three months) or intermediate (six months) follow-up. Manipulation may be more effective than massage in improving pain and function in patients with chronic cervical headache at short/intermediate follow-up, and may be favored over TENS for pain reduction at short-term.

The recommended frequency of manipulation therapy is one to two times per week for the first two weeks, and one treatment per week for the next six to eight weeks. At week 8, patients should be re-evaluated [103].

Contraindications include myelopathy, severe degenerative changes, fracture or dislocation, infection, malignancy, ligamentous instability, and vertebrobasilar insufficiency [65]. Relative contraindications include stenosis, spondylosis, and disk herniation [103].

Vertebral artery dissection caused by high-velocity, low-amplitude thrusting is a rare but recognized outcome. Vascular accidents following extension and rotation of the neck beyond the physiologic range lead to a cascade of events including thrombosis, stroke, and death [221]. More than 400 cases following cervical manipulation have described arterial dissection, brain stem injury, cerebellar injury, spinal cord injury, thrombosis, locked-in syndrome, joint dislocation, and death. Risk of these rare but catastrophic events can be minimized by avoiding extension-based high-velocity, low-amplitude thrust [16].

Joint Mobilization

Joint mobilization techniques incorporate a low-velocity and small- or large-amplitude oscillatory movement, within a joint's passive range of motion [8]. A mobilization treatment consists of passive movement involving oscillatory motions to the vertebral segment(s). The passive mobility is performed in a graded manner (I, II, III, IV, or V), which depicts the speed and depth of joint motion during the maneuver. Mobilization may include skilled manual joint tissue stretching [103]. Other modalities include myofascial releases, counterstrain, and indirect or direct muscle energy techniques [16]. Indications include the need to improve joint play, segmental alignment, or intracapsular arthrokinematics or to reduce pain associated with tissue impingement. Mobilization should be accompanied by active therapy [103].

A 2015 Cochrane review of mobilization therapy in neck pain noted anterior-posterior mobilization may favor pain reduction over rotatory or transverse mobilizations at immediate follow-up in patients with acute and subacute neck pain [220]. For those with subacute and chronic neck pain, cervical mobilization alone may not be different from ultrasound, TENS, acupuncture, and massage in improving pain, function, quality of life, and participant satisfaction at immediate and intermediate follow-up. Multiple sessions of TMD manual therapy may be more effective than cervical mobilization in improving pain/function at immediate and intermediate follow-up for patients with chronic cervical headache and TMD.

For grade V mobilization, contraindications include joint instability, fracture, severe osteoporosis, infection, metastatic cancer, active inflammatory arthritides, and signs of progressive neurologic deficits, myelopathy, vertebrobasilar insufficiency, or carotid artery disease. Relative contraindications include stenosis, spondylosis, and disk herniation [103].

Manipulation and Joint Mobilization Co-Therapy

Manipulation and mobilization show similar results on most outcomes. In acute and chronic neck pain, manipulation and cervical mobilization produced similar changes in pain, function, quality of life, global perceived effect, and patient satisfaction at immediate-, short-, and intermediate-term follow-up [220].

Outcomes with gentle mobilization were superior to physical therapy and comparable to high-velocity, low-amplitude thrust [220]. For mechanical neck disorders, manipulation or mobilization were more beneficial combined with exercise than as monotherapy [16]. Short-term improvement is documented in acute whiplash pain, cervicogenic headache, and radiculopathy secondary to disk herniation, but others conclude that mobilization or manipulation in patients with radicular findings has insufficient evidential support [16; 51]. No evidence exists that manipulation confers long-term benefit, improves chronic conditions, or alters the natural course of a neck pain disorder [16].

MECHANICAL AND MANUAL TRACTION

Manual or mechanically assisted traction applies an intermittent or continuous distractive force to the cervical spine. Distraction refers to gentle pulling of the head upward to relieve pressure and compression of joints or nerve roots in the cervical spine [8].

Traction is initiated manually by a physiotherapist or as a component of manipulation or mobilization treatment. The usual course of treatment is two to three times per week for four weeks. Patients who benefit from manual traction should continue with a home cervical traction unit [103].

Traction regimens may be heavy weight-intermittent or light weight-continuous. The neck is flexed 15–20 degrees (i.e., not extended) during traction. In the cervical spine, 10 pounds of force is necessary to counter gravity and 25 pounds of force is needed to achieve separation of posterior vertebral segments. Light weight-continuous home traction is cost-effective and provides greater autonomy to the patient. Pneumatic traction devices afford greater patient comfort, which can increase treatment adherence [51].

Traction is popular among patients with cervical radiculopathy, but it is contraindicated with tumor, infection, fracture, or dislocation [103]. Mechanical traction is widely used to promote cervical immobilization and widen the foraminal openings. Cervical traction may relieve radicular pain from nerve root compression, but it does not improve pain from soft-tissue injury. Hot packs, massage, or electrical stimulation should be applied before traction to relieve pain and relax muscles [65].

IMMOBILIZATION

Immobilization limits neck motion to reduce nerve or soft tissue irritation, and soft cervical collars are the most widely used device. For acute soft-tissue neck injuries, cervical collar use should not exceed three to four consecutive days to avoid risks of losing cervical range of motion and neck strength from muscle disuse and atrophy [51].

In radiculopathy caused by foraminal stenosis, the wide part of the collar is placed posteriorly, with the thin part placed anteriorly to promote neck flexion, discourage extension, and open the intervertebral foramina. Cervical collars can be worn during sleep or distance-driving [51].

In severe cervical spondylosis with evidence of myelopathy, cervical spine immobilization is the mainstay of conservative treatment. Soft cervical collars do not sufficiently limit cervical spine motion and should only be used in daytime. More rigid orthoses adequately immobilize the cervical spine; isometric cervical exercises may help limit loss of muscle tone [65].

PASSIVE ASSISTIVE DEVICES

Passive assistive devices inhibit or prevent movement [8]. Molded cervical pillows can better align the spine during sleep and provide symptom relief for some patients [65].

THERMOTHERAPY

Thermotherapy applies heat or cold to superficial or deep tissue. Superficial thermotherapy applies heat or cold to raise or lower skin tissue temperatures. This approach is indicated for reducing acute pain, edema, muscle spasm, and inflammation, or for promoting stretching/flexibility. Heat packs or hydrotherapy can apply heat, while cold packs or vapocoolant spray can apply cold. Cold and heat packs can be used at home [8; 103].

Deep tissue thermotherapy is applied to affect structures beneath the skin surface and includes low-level laser, electrical muscle stimulation, pulsed electromagnetic therapy, and ultrasonic heat [8]. Electrical muscle stimulation is indicated for muscle spasm or atrophy with varying frequencies, from twice daily to once weekly. A home unit should be purchased, if effective. Short-wave diathermy applies an electromagnetic field to soft tissues to reduce muscle guarding, inflammation, or edema, typically two to three times per week for three to five weeks [103].

TRANSCUTANEOUS ELECTRICAL NERVE STIMULATION

Indications for TENS therapy in patients with neck pain include muscle spasm, atrophy, and decreased circulation and pain control. Minimal TENS unit parameters should include pulse rate, pulse width, and amplitude modulation. In patients with pain relief using TENS, also consider functional improvement before prescribing for purchase of a home unit [103].

EVIDENCE-BASED PRACTICE RECOMMENDATION

For patients with chronic neck pain with movement coordination impairments (including WAD), the American Physical Therapy Association asserts that appropriate treatment options are education, TENS, and cervical mobilization plus individualized progressive exercise.

(https://www.jospt.org/doi/full/10.2519/jospt.2017.0302. Last accessed September 23, 2022.)

Strength of recommendation/Level of Evidence: C (Weak recommendation based on one or more level III systematic reviews or a preponderance of level IV evidence supports the recommendation, providing minimal evidence of effect)

PHYSICAL AND EXERCISE THERAPIES

Functional Restoration Programs

Functional restoration programs assist patients disabled by chronic cervical pain to overcome obstacles to recovery, such as deconditioning, secondary gain, poor motivation, and psychopathology. Patients should receive education on cervical anatomy, biomechanics, pathology, and ergonomics, and develop preventive strategies that protect against further injury during daily activities. These medically directed interdisciplinary programs have been successful in helping workers' compensation patients return to work and in reducing recurrent injury, new surgeries, and healthcare use in patients with chronic cervical pain who successfully complete a program [51].

The McKenzie Approach

For most cervical disk disorders, studies support conservative treatment, such as the McKenzie approach or cervicothoracic stabilization programs combined with aerobic conditioning. The McKenzie system identifies three mechanical syndromes that cause pain and compromise function [51]:

- The postural syndrome: Provokes pain when normal soft tissues are loaded statically at end-range of motion. Treatment aims to correct posture.
- The dysfunction syndrome: Produces pain when the patient attempting full movement mechanically deforms contracted scarred soft tissue. Therapy involves stretching and remodeling of such contracted tissue.
- The derangement syndrome: Produces intermittent pain with certain movements or postures from activity-dependent displacement of intradiscal material. Therapy attempts to correct derangement by promoting activity that centralizes pain.

The McKenzie theory recognizes that patients may demonstrate similar signs and symptoms, but one movement (i.e., cervical extension) may help some patients and aggravate symptoms in others. In McKenzie therapy, treatment individualization plays a key role [51].

Cervicothoracic Stabilization Programs

Cervicothoracic stabilization programs reduce pain, maximize function, and prevent further injury through cervical spine flexibility, postural training, and strengthening [51; 103]. Flexibility restoration prevents further repetitive microtrauma resulting from poor movement patterning. Soft tissue or joint restriction that inhibits range of motion is treated, and range of motion is restored through spine and soft-tissue mobilization, passive range of motion, self-stretching, and correct posturing.

Postural training in spinal stabilization uses mirrors and therapist feedback to maintain neutral spine and correct posture during daily activities. Patients learn whole-body movements while maintaining a stabilized spine, and progress to controlled movement of the spine that approximates normal biomechanical motions without creating undue vertebral stress.

Cervicothoracic stabilization requires strengthening and coordination of neck, shoulder, and scapular muscles, as well as training of the lumbar spine and lower extremities to provide a foundation for the cervicothoracic spine. Stabilization exercises proceed systematically from simple to complex.

Isometric and isotonic resistive exercises employ elastic bands, weight machines, and free weights. Such conditioning distributes forces away from the cervical spine. Exercise repetition ultimately encodes an engram that commands immediate, automatic cervicothoracic stabilization during everyday activity. Proprioceptive skills are used during strengthening exercises to facilitate stable, safe, and pain-free cervical posture during strenuous activity.

Neuromuscular Re-Education

Neuromuscular re-education and movement training involves stabilizing and mobilizing muscles, proper sequencing, and optimal biomechanical motion patterns for daily tasks and activities. Tasks are broken down into their component single-joint movement patterns and perfected with proper alignment, breathing, and muscle stabilization in non-weight-bearing postures using manual or mechanical assistance. After single-joint patterns are mastered without symptoms, the training complexity increases, with multi-joint movement, non-linear motion (circular or diagonal), weight-bearing postures, proprioceptive challenges (e.g., eyes closed, unstable surfaces), progressive resistance, and/or variable speeds and durations. The end goal is to transition the patient from movement incompetence to a state of automatic movement competence [222]. Directional exercises are used in pain-generators that show "directional preference" to apply beneficial mechanical loads that correct the abnormality and avoid loading in the direction of vulnerability [222].

In cervical myofascial pain, the goal of physical therapy is to restore balance between muscles working as a functional unit, accomplished using cervical stretch and stabilization, myofascial release techniques, massage, and postural retraining [57].

Strengthening Exercise

General exercise is defined as purposeful physical activity involving repetitive exercises that incorporate multiple muscle groups [223]. In contrast, therapeutic exercise programs should be specific to the injury and address general functional deficits as identified in the diagnosis and clinical assessment. Common specific approaches include strengthening, stretching/range of motion, and flexibility training [8].

Many patients with spine-related symptoms and functional deficits lose strength in specific muscles or muscle groups from neurologic compromise, disuse, and deconditioning. Strength training rehabilitation is used for restoring muscle loss and reversing changes, and for easing recurrent spine-related symptoms in patients with pre-episode deficits. This process can take many months of effort. In the early phases, most gains are in learning and neuromuscular adaptation, which lead to better efficiency and economy of movement [222].

Strengthening is initiated under trained supervision and is later self-directed. Strength training is performed two to five days per week, with any number of movement patterns performed 8 to 20 times over two to four sets. The loads, intensity, volume, and duration used for desired outcomes vary greatly. Equipment that can assist in strengthening includes barbells and dumbbells, exercise machines, medicine balls, and elastic cords [222].

Stretching

Lack of flexibility in certain muscle groups is linked to spine-related symptoms. A causal relationship is not established, but improving the flexibility of muscle, tendon, and connective tissue elements may enhance recovery and reduce focal areas of tension and stress. Stretching involves techniques ranging from static, passive, low-load, long-duration strategies applied by a therapist, to contract-relax tactics that enhance muscle reception to stretching [222].

Patients should continue exercise and stretching therapies at home as an extension of the treatment process to maintain improvement levels. Follow-up visits to reinforce and monitor progress and proper technique are recommended. Home exercise can include exercise with or without mechanical assistance or resistance and functional activities with assistive devices [103].

Evidence of Efficacy

Strengthening tailored to individual patients with neck pain is superior to generalized strengthening [222]. A 2016 practice guideline stated that supervised qigong, Iyengar yoga, and programs that combined strengthening, range of motion, and flexibility were effective in persistent neck pain; exercise alone had minimal benefit [224].

Exercise combined with any blend of manipulation, mobilization, muscle energy, and stretching is more effective in reducing neck pain and disability than any single approach used alone [103]. A systematic review of exercise efficacy in neck pain disorders concluded that use of strengthening and endurance exercises for the cervico-scapulothoracic region and shoulder may be beneficial in reducing pain and improving function; and that stretching exercises alone are not beneficial [225]. In acute radiculopathy, cervical stretch, strengthening, and stabilization exercises show a small benefit in pain reduction. For chronic neck pain, the authors identified five modalities with some evidence of efficacy for neck pain [225]:

- Cervico-scapulothoracic and upper extremity strength training: Moderate to large improvements in pain at short-term follow-up
- Scapulothoracic and upper extremity endurance training: Smaller beneficial effect on pain at short-term follow-up
- Combined cervical, shoulder, and scapulo-thoracic strengthening and stretching exercises: Smaller to large-magnitude benefit on pain from post-treatment to long-term follow-up, and a medium magnitude of effect on improved function at short-term follow-up
- Cervico-scapulothoracic strengthening/stabilization exercises: Improved pain and function at intermediate-term follow-up
- Mindfulness exercises and qigong: Minimally improved function at short term

The study also determined that weak evidence suggested minimal-to-no short-term benefit on pain or function with breathing exercises, general fitness training, stretching alone, and feedback exercises with pattern synchronization. Very weak evidence suggests neuromuscular eye-neck coordination and proprioceptive exercises may improve pain and function short-term [225].

In patients with chronic cervicogenic headache, static-dynamic cervico-scapulothoracic strengthening/endurance exercises (including pressure biofeedback) were found to improve pain, function, and global perceived effect at post-treatment and probably at long-term follow-up [225]. Low-grade evidence supports sustained natural apophyseal glide exercises in this patient population.

Two randomized controlled trials compared the outcomes of patients with chronic nonspecific neck pain after four weeks of stabilization exercises alone or combined with a manual therapy. In the first trial, patients receiving cervical and scapulothoracic stabilization exercises plus manual therapy showed significantly greater improvements in pressure pain threshold, disability, pain intensity at night, cervical rotation motion, and quality of life than patients receiving exercises alone [226].

The second trial compared cervical and scapulothoracic stabilization exercises alone or plus connective tissue massage. Both decreased pain intensity and anxiety levels, but combination therapy led to significantly greater improvements in pain intensity at night, pressure pain threshold, state anxiety, and mental health than exercises alone [227]. At six-month follow-up, patients with chronic nonspecific neck pain showed significantly greater reductions in pain and disability from global postural re-education than manual therapy (nine 1-hour sessions for both) [228].

The Alexander technique is an educational approach to modify dysfunctional posture, movement, and thinking patterns associated with musculoskeletal disorders. In patients with chronic nonspecific neck pain, the Alexander technique did not differ from local heat application in pain reduction after both were delivered weekly for five weeks [229].

Consensus indicates that exercise therapy is beneficial for chronic pain, but the lack of endogenous analgesia in some chronic pain disorders should not be ignored and clinicians should account for this when treating patients with chronic pain [230]. General exercise is frequently recommended for WADs. In contrast to other musculoskeletal pain conditions, a review of high-quality studies concluded general exercise does not reduce pain or disability in patients with WAD [223].

Exercise-induced hypoalgesia describes the desired effect of reduced pain sensitivity following exercise. The effect of acute exercise on pain sensitivity in chronic pain conditions is controversial, because hypoalgesia, unchanged pain sensitivity, and hyperalgesia (impaired exercise-induced hypoalgesia) have all been reported. Evidence suggests impaired exercise-induced hypoalgesia is evident in WAD following aerobic exercise [231].

In patients with chronic WAD, exercise-induced hypoalgesia responses to isometric (3-minute wall squat) or aerobic (30 minute bicycling) exercise were compared by recording neck and leg pressure pain thresholds before and after exercises. Pressure pain threshold increases were found at both areas after isometric, but not aerobic, exercise. Isometric exercises directed at non-painful muscles may reduce local and remote pain sensitivity in patients with chronic WAD and mild-to-moderate neck pain and disability [232].

In patients with chronic neck pain, exercise-induced hypoalgesia after isometric exercises seems less dependent on exercise intensity than aerobic exercises, which may increase adherence. Isometric exercise has potential as a rehabilitation component to target central mechanisms of pain [231].

PSYCHOSOCIAL INTERVENTIONS

People with chronic pain are not passive; they actively attempt to change the causes of pain and their behavior in response to pain. For many patients, such change without therapeutic help is unachievable, and repeated misdirected efforts to resolve their pain problem can drive a cycle of pain, depression, and disability. Psychologic interventions are designed to promote adaptive pain management and reduce the consequences [233]. As such, psychosocial interventions are used in select patients with acute or chronic pain. Examples include cognitive-behavioral therapy (CBT), relaxation training, mindfulness training, and sleep hygiene training.

Cognitive-Behavioral Therapy

CBT is widely used in the treatment of pain-related functional impairments and disabilities. In general, CBT is a skills-training intervention that emphasizes identifying and changing maladaptive cognitions, emotions, and behaviors, and can be delivered in individual or group-based sessions [79].

In fear-avoidance, CBT targets pain catastrophizing and avoidant beliefs (maladaptive cognitions), fear (a maladaptive emotion), and avoidant (maladaptive) behaviors by helping the patient develop and apply coping strategies that enhance problem-solving for successfully confronting and self-managing health-related threats posed by pain. Core elements of this approach are [79; 234]:

- Graded homework assignments
- Cognitive restructuring (i.e., learning how to challenge maladaptive cognitions)
- Relaxation training (e.g., diaphragmatic breathing, progressive muscle relaxation, imagery)
- Time-based activity pacing (paced by time and not task completion)
- Extinguishing pain behaviors (i.e., verbal and nonverbal expressions of pain)

Other strategies taught to patients include distraction (diverting attention away from pain), reinterpretation (changing thoughts about pain), dissociation (separating pain from other sensations), coping self-statements (affirming self-messages), and emotional disclosure (expressive writing) [234].

CBT is widely endorsed for patients with subacute or chronic spinal pain and comorbid psychosocial conditions. CBT can lead to long-term improvements in pain intensity, disability, quality of life, pain-related coping, depressed mood, and health care-seeking behaviors. The favorable effects of CBT on pain outcomes are supported by functional imaging studies [79; 235].

Two systematic reviews found inconsistent evidence of pain reduction with CBT. In chronic neck pain, changes in pain and disability were only found when CBT was compared with no treatment, and no effects on kinesiophobia were found. In subacute neck pain, CBT showed benefit in pain relief but not disability compared with other interventions, but the size of these effects was not clinically meaningful. These conclusions were stated as based on low-quality evidence, which might change with new data [236].

A broader review of psychologic interventions evaluated recent-onset and persistent neck pain separately [237]. In persistent (three to six months) neck pain with or without radiculopathy, researchers found no clear evidence supporting CBT or relaxation training for reducing pain intensity or disability; however, they did find that Jyoti (candle or light) meditation may help reduce neck pain intensity and bothersomeness. In persistent post-whiplash pain, evidence to support the efficacy of biofeedback or relaxation training was not found, and evidence for using CBT was conflicting. Adding progressive goal attainment to functional restoration physiotherapy may benefit these patients.

In recent-onset (less than three months) neck or post-whiplash pain, there was no evidence for or against using psychologic interventions. The limited evidence support for psychologic interventions may reflect interventions that are ineffective or poorly conceptualized or implemented [237].

In another study, a physiotherapist-led cognitive-behavioral intervention was effective in modifying cognitive risk factors in patients with chronic neck pain. These patients showed larger increases in functional self-efficacy, greater reductions in pain intensity and pain-related fear, and a greater proportion attained clinically meaningful reductions in pain and disability compared with patients randomized to a progressive neck exercise program. Both were delivered in group format [238].

One randomized controlled study compared two brief cognitive-behavioral programs that included sessions of multimodal exercises [239]. Fifteen patients underwent four sessions of CBT based on the NeckPix—a measure of pain-related fears of a specific set of activities of daily living. Another 15 patients received four sessions of CBT based on the Tampa Scale of Kinesiophobia—a patient self-report questionnaire designed to evaluate fear of movement, fear of physical activity, and fear avoidance. Following CBT, both groups attended 10 sessions of multimodal exercises for five weeks' duration [239]. No changes were found in neck disability index at the end of CBT, while a significant improvement was found for both groups at the end of motor training. Similarly, there was no change in quality of life after CBT, and a significant change at the end of motor training, with a partial loss at follow-up. From CBT sessions to follow-up, both groups showed progressive reduction in kinesiophobia [239].

ALTERNATIVE AND COMPLEMENTARY APPROACHES

Acupuncture

Acupuncture therapy is one of most popular complementary approaches and has become a widely accepted treatment for diverse pain-related conditions [240]. Acupuncture therapy involves insertion of needles into the skin and underlying tissues at specific sites, known as acupoints, to reduce pain or induce anesthesia. Needles may be manipulated manually or through electrical stimulation [2; 8].

The persistence of therapeutic effects following a course of acupuncture was evaluated in a meta-analysis of 29 randomized controlled trials of diverse chronic pain. Depending on the control group (no-acupuncture versus sham acupuncture), 50%

to 90% of acupuncture benefit was sustained 12 months after treatment and did not seem to decrease importantly in chronic pain [241]. Patients can generally be reassured that treatment effects persist. Questions of acupuncture cost-effectiveness can take these findings into account.

Acupuncture is not without risks. Deaths and serious nonfatal complications of acupuncture are reported, with pneumothorax the most frequent fatal and non-fatal cause. All deaths were avoidable with proper acupuncture technique and sufficient anatomic knowledge. Most reports originated in East Asia, but some came from the United States and Western Europe [221].

Yoga, Qigong, and Tai Chi

Iyengar yoga involves a range of classical yoga poses adapted to patients with neck pain with the use of supportive props. Emphasis is placed on muscle strengthening, stretching, joint mobility, and proper posture [8]. A systematic review found evidence for significant short-term benefits in neck pain intensity, neck pain-related disability, quality of life, and mood, suggesting that yoga might be a good treatment option in chronic nonspecific neck pain [242].

With origins in traditional Chinese medicine, qigong and tai chi are gentle, focused exercises for the mind and body that aim to increase and restore the flow of *qi* energy and encourage healing [8]. In one study, patients with chronic nonspecific neck pain were randomized to 12 weeks of group tai chi, sessions of conventional neck exercises, or to a wait-list control group. Tai chi and exercise intervention did not differ, and both significantly improved pain on movement, functional disability, and quality of life compared with the wait-list group [243].

Of 89 patients with chronic neck pain randomized to 8 weeks of Jyoti meditation or self-care exercise program, meditation training significantly reduced pain and pain-related bothersomeness compared with the exercise group. Researchers suggest that mediation may support patients with chronic pain in pain reduction and pain coping [244].

INTERVENTIONAL AND SURGICAL THERAPIES

Interventional modalities involve injection or ablation approaches in the treatment of spinal pain. They are considered minimally invasive, in contrast to spinal surgery, which is invasive. Cervical epidural, spinal nerve root, facet joint, and sympathetic injections serve diagnostic and therapeutic roles. These procedures can be instrumental in identifying the anatomic pain generator (e.g., nerve root, facet joint) and providing aggressive treatment [51].

Cervical Epidural Injections

For cervical radiculopathy, epidural steroid injections place a corticosteroid and anesthetic (lidocaine or bupivacaine) into the epidural space (interlaminar) or along the nerve root (transforaminal) under radiographic guidance. Epidural steroid injections are thought to reduce pain by interrupting the inflammatory cascade, blocking C-fiber transmission, increasing microcirculation around ischemic areas, and/or modulating pain transmission in the dorsal horn [245; 246].

Rare but catastrophic neurovascular complications following cervical transforaminal steroid injections have resulted from particulate matter in corticosteroid preparations. Only the nonparticulate steroid dexamethasone should be used in cervical transforaminal injections. All epidural steroid injections should be performed under radiographic guidance to avoid serious CNS injuries [247].

Epidural steroid injections can induce dose-dependent suppression of the hypothalamic-pituitary-adrenal axis lasting one to three months. Steroids provide no additional benefit to local anesthetic (bupivacaine) alone in pain, function, or disability. Considering local and systemic risks versus negligible benefit, adding a corticosteroid to local anesthetic is not recommended. Aside from cervical radiculopathy, epidural injections are not indicated for other neck pain conditions [2; 248; 249].

Cervical Facet Joint Interventions

Facet joint interventions identify and treat facet-mediated pain. To identify facet joints as the pain source, inter-articular injections of local anesthetic are placed into facet joints or along their innervating nerve fibers (sensory medial branch). A separate comparative block is performed on a different date to confirm the level of involvement and reduce placebo response. Pain relief from both medial branch nerve blocks confirms facet origin, and radiofrequency ablation is indicated for extended pain control [50; 250].

Radiofrequency neurotomy applies a radiofrequency current with heat sufficient to ablate the afferent nerve supply of the facet joint. Denervating these joints is effective in relieving pain and restoring function in these patients. Nerve regeneration occurs 9 to 12 months post-radiofrequency neurotomy, but repeat radiofrequency neurotomy is usually successful and longer-lasting [103; 251]. Continuous radiofrequency neurotomy is the preferred method; pulsed radiofrequency neurotomy should not be used, as it may result in incomplete denervation [50]. Precise positioning of the radiofrequency probe with fluoroscopic guidance is required [103].

A systematic review of cervical medial branch thermal radiofrequency neurotomy found most patients were pain-free at six months and more than 33% reported being free of pain at one year [252]. The evidence of effectiveness was rated as high quality. Side effects were reported in 12 studies; most were minor and temporary. Adhering to International Spine Intervention Society guidelines on fluoroscopic-guided cervical medial branch thermal radiofrequency neurotomy was stressed; when performed as described, cervical medial branch thermal radiofrequency neurotomy is effective for resolving chronic facet joint pain and carries only minor risks [252]. Repeat procedures may lead to atrophy of supportive spinal musculature from denervation of sensory and motor nerve inputs. Focused physical therapy may mitigate this risk [103].

Trigger Point Injections

Trigger point injection with a local anesthetic (with or without corticosteroid) is widely used in treating myofascial pain. With trigger point injection, the trigger point in the taut muscle band is palpated, slightly stretched to prevent it from moving, and injected. The needle is redirected in the area to ensure injectate distribution. The fast-in/fast-out method is the most successful in eliciting a local twitch response (which helps confirm diagnosis) and reducing myofascial pain [57]. Sedation is not needed for trigger point injection [103]. The efficacy of this approach is enhanced when immediately followed by a myofascial intervention [57; 103].

There are two main approaches to trigger point injection. The first is the stretch and spray technique, in which areas around the trigger point and referred pain are stretched using parallel strokes in the same direction, and a vapocoolant spray is applied. A variant involves spraying first, then stretching, and repeating the spraying. The second is ischemic compression (myotherapy). With this approach, the affected muscle is placed in a fully stretched position and sustained pressure by thumb press is applied on the trigger point, with pressure gradually increased as the pain lessens. Specific soft tissue mobilization or physical modalities may be used with either approach.

Rare trigger point injection complications include infection, pneumothorax, anaphylaxis, neurapraxia, and neuropathy. Corticosteroid injection carries a risk of local myopathy. Severe pain on trigger point injection suggests an intraneural injection, and the needle should be immediately repositioned [103].

Intradiscal Interventions

A variety of different approaches have been used to address diskogenic pain. In the treatment of cervical diskogenic pain, thermal annuloplasty applies heat along the annulus fibrosus to denervate the annulus and/or reconfigure the collagen structure of the disk [253]. Coblation nucleoplasty applies bipolar radiofrequency current to decrease the volume of disk tissue. Intradiscal electrothermal therapy places

an electrode or catheter into the annulus of the disk and applies electrothermal energy to denervate the annulus. Percutaneous intradiscal radiofrequency places an electrode or catheter into a disk to apply alternating radiofrequency current.

Diskography is used for identifying the disk as the axial pain source by placing contrast dye into the intervertebral disk under fluoroscopy before CT imaging. The validity of diskography remains controversial, and there is concern that the procedure may accelerate disk degeneration [254; 255].

Disk Decompression

In treating radicular pain secondary to intervertebral disk herniation, percutaneous disk decompression is used to remove a portion of disk material in order to reduce intradiscal pressure and decompress the involved nerve [256]. One study found that the use of percutaneous laser disk decompression reduced pain and disability in patients. The study included 30 patients (11 men and 19 women). The procedure decreased both pain and disability scores, with no statistical difference found between men and women [257].

Vertebroplasty consists of injecting polymethyl methacrylate cement into the vertebral body. Kyphoplasty involves inflating a balloon within the vertebral body before polymethyl methacrylate is injected. The proposed mechanism is the combination of thermal necrosis and chemotoxicity of intraosseous pain receptors [258]. Vertebroplasty did not show benefit over sham or placebo interventions in two large randomized trials [259]. One study compared vertebroplasty, kyphoplasty, and nonsurgical management of vertebral compression fractures among 7,290 patients. Outcomes assessed included reoperation rates, complications, and overall costs [260]. A total of 7,290 patients were included (75.5% women; average age: 78 years). Reoperation rates ranged from 6% to 17%, and complication rates ranged from 7% to 10%. Overall costs were significantly greater in both the kyphoplasty and vertebroplasty groups at one-year follow-up, but not at two-year and four-year follow-up [260].

Botulinum Toxin A Injections

Botulinum toxin A reduces muscular contractions and spasm by inhibiting acetylcholine release into the neuromuscular junction. Compared with placebo, trigger point injections of botulinum toxin A into painful muscles significantly improved pain scores, reduced headaches per week, and improved general activity and sleep after 12 weeks in patients with severe shoulder girdle and chronic cervical myofascial pain [261]. Trigger point injections with botulinum toxin A for chronic cervical myofascial pain are now considered supported by the available evidence [262; 263]. Side effects with cervical botulinum toxin A injection include transient dysphagia, neck weakness, dry mouth, and vocal hoarseness [103].

Botulinum toxin A may also be effective in relieving primary headache disorders, trigeminal neuralgia, chronic neuropathic pain, and nociceptive and osteoarticular pain. The favorable side effect profile and long-lasting pain relief after a single injection, when effective, makes botulinum toxin A an attractive treatment option. As neck pain therapy, optimal dosing and patient selection need clarification [264].

Cervical Spine Surgery

Cervical spine surgery is indicated when natural history and prognosis with surgical treatment is better than with non-operative treatment. Indications include progressive neurologic deficits, compression of the cervical nerve root and/or spinal cord, or intractable pain. Cervical spine surgical outcomes are most favorable for radicular pain, spinal instability, progressive myelopathy, or upper extremity weakness [51; 65; 103]. Detailed discussion of cervical spine surgeries is beyond the scope of this course.

CHRONIC REFRACTORY NECK PAIN

In patients with chronic neck pain refractory to standard therapies, established therapeutic options include stimulation of spinal dorsal horn columns to block spinal pain transmission, or intrathecal drug delivery systems to deliver opioids, with or without other medications, to maximize effectiveness and reduce systemic side effects [254].

CONCLUSION

A significant proportion of acute neck pain resolves with conservative management. However, chronic neck pain is substantially more difficult to treat and can develop from an acute neck injury or insidiously over time. Long-term changes in the CNS maintain chronic pain. Anatomic, biochemical, and functional abnormalities develop in the brain and spinal cord that amplify pain perception and perpetuate pain.

Pharmacologic and nonpharmacologic therapies have shown disappointing long-term outcomes in chronic pain. Pharmacotherapy focusing on tissue pathology has contributed to inadequate pain reduction. As such, pain mechanism identification and targeting is increasingly stressed, and combining pharmacotherapies that target different pain mechanisms is also emphasized. A substantial volume of new research is changing chronic pain assessment and treatment, and its uptake into clinical practice brings optimism for improving pain and functioning of patients with chronic neck pain in the near future.

Implicit Bias in Health Care

The role of implicit biases on healthcare outcomes has become a concern, as there is some evidence that implicit biases contribute to health disparities, professionals' attitudes toward and interactions with patients, quality of care, diagnoses, and treatment decisions. This may produce differences in help-seeking, diagnoses, and ultimately treatments and interventions. Implicit biases may also unwittingly produce professional behaviors, attitudes, and interactions that reduce patients' trust and comfort with their provider, leading to earlier termination of visits and/or reduced adherence and follow-up. Disadvantaged groups are marginalized in the healthcare system and vulnerable on multiple levels; health professionals' implicit biases can further exacerbate these existing disadvantages.

Interventions or strategies designed to reduce implicit bias may be categorized as change-based or control-based. Change-based interventions focus on reducing or changing cognitive associations underlying implicit biases. These interventions might include challenging stereotypes. Conversely, control-based interventions involve reducing the effects of the implicit bias on the individual's behaviors. These strategies include increasing awareness of biased thoughts and responses. The two types of interventions are not mutually exclusive and may be used synergistically.

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