CLINICAL PRACTICE GUIDELINE: CERVICAL OR NECK PAIN (NON-TRAUMATIC) (1B)

SYSTEMATIC REVIEW FOR IMAGING OF CERVICAL SPINE ASSOCIATED WITH SPECIFIC, NON-SPECIFIC, ACUTE AND CHRONIC NECK PAIN

CPG 1B Abstract (Updated July 2019)

Cervical or neck pain is common with an annual prevalence rate of 30% or more and is the sixth leading cause of disability (Cohen, 2015; Mokdad et al., 2018). Prevalence peaks at middle age, supporting a multimodal etiology of repetitive stress and strain; other risk factors include previous injury, smoking, and degenerative joint disease (Cohen, 2015).

The insidious nature of cervical neck pain makes classification difficult. Pain may be the result of repetitive trauma over time or secondary to acute injury. Discomfort may be chronic yet increasingly severe. Furthermore, cervical anatomy presents a diagnostic challenge as discomfort may result from injury or inflammation to any number of structures including the bony cervical column and complex soft tissues including the spinal cord, nerve roots, and tendons/ligaments/muscles.

Most neck pain conditions are not amenable to diagnosis using objective clinical criteria. Thus, symptoms and signs, assisted by radiographic imaging when appropriate, constitute the primary method for diagnosis. Currently, the most utilized studies in the evaluation of neck pain include plain film radiographs (XR), magnetic resonance (MR) imaging, computed tomography (CT), and electro-diagnostic studies such as electromyography (EMG) and nerve conduction velocity (NCV) tests.

Although imaging algorithms do exist to guide the practitioner, most lack consensus. Nevertheless, several generalizations may be made. XR and CT provide excellent visualization of the cervical vertebral bodies and other bony structures whereas the strength of MR is its ability to evaluate the spinal cord, nerve roots, and surrounding soft tissue structures. CT-M is an invasive procedure whereby contrast is injected into the spinal column prior to CT imaging. Excellent visualization of the spinal canal is afforded with this method, prompting several comparative studies with MR imaging. Although the use of CT myelography has declined in recent years, this invasive procedure is still commonly used in selected cases where MRI is technically difficult or contraindicated.

Epidural steroid injection (ESI) is performed for chronic cervical radicular pain management. ESI is performed under **fluoroscopic** and/or **computed tomographic (CT)** guidance and requires a small volume of contrast injection to confirm needle placement (Van Boxem et al., 2019; Rathmell et al., 2015). Image-guided cervical spine procedures for axial neck pain also include medial branch blocks and radiofrequency ablation. Recent studies also support ultrasound guidance for some cervical spine interventions (e.g. cervical medial branch blocks, cervical transforaminal epidural steroid injections/selective nerve root blocks, cervical intra-articular

facet joint injections). Ultrasound demonstrates similar efficacy to that of fluoroscopy and/or CT (Wald et al., 2014), while posing no radiation risk. Patient obesity and operator-dependence, however, limit more widespread use of ultrasound.

Multiple factors affect the decision-making process when evaluating the appropriateness of ordering imaging studies. These include cost (both initial and 'downstream'), availability, patient preference and expectations, radiation exposure concerns, prior imaging results, and presence of contraindications for a specific modality. Further, such factors are not always quantifiable and frequently vary across therapeutic settings. Panelists review available literature to recommend appropriate imaging studies in specific clinical scenarios but acknowledge that these other variables impact the decision-making process and are not necessarily addressed by published literature. In the recommendation justifications, these issues would be part of the consideration, especially when the resulting "grade" is judged to be "Consensus" rather than based upon strong clinical evidence.

Database Sources: ResearchGate, PubMed, Cochrane Library, Google Scholar, Cochrane Central Registry of Controlled Trials, Cochrane Database of Systematic Reviews

Search Strategy: For this annual review, a systematic search and a thorough review of the medical literature focused on non-traumatic neck pain in adults and appropriate diagnostic imaging techniques, published in the last five year through July 2019, was conducted. The advanced search option in PubMed/Medline was used, incorporating the search strategy utilizing Population, Intervention, Comparator, Outcome (PICO) framework.

Keywords: The following keywords (using MeSH and full-text search strings) were used individually or in different permutations and/or combinations using Boolean Operators: non-traumatic neck pain, cervical spine, cervical vertebrae, imaging, diagnostic imaging, x-ray, plain radiograph, CT, computed tomography, pathologic fracture, interventional pain management, MRI, MR Imaging, magnetic resonance imaging, sensitivity and specificity, and diagnostic accuracy.

Methods: A total of 1657 articles resulted from the general non-traumatic neck pain topic search. References of relevant articles were scanned for potentially missing studies. Titles and abstracts were scanned, and then full articles were reviewed. The articles were evaluated and considered from the following groups: imaging or diagnostic imaging in adults (232 articles), initial assessment or clinical evaluation (17 articles), x-ray (31 articles), and CT (27 articles), and MRI (98 articles). Some articles were considered for more than one group. Finally, these articles were evaluated, based, in part, upon study design, sample size, and public availability. They were further reviewed to see if they answer the respective PICO questions.

Based on 2019 literature review the following changes have been made to the Clinical Practice Guideline:

1) CT and CT myelography imaging have been combined under a broader spectrum of CT imaging modalities. 2) The previous 3 PICO's covering MR imaging modalities have been combined into 2 PICOs covering malignancies and other clinical predictors guiding MR imaging. 3) A new PICO has been created for the role of imaging guidance in interventional pain management.

Clinical Focus Questions

PICO #1: In adults with non-traumatic neck pain, is imaging always warranted for initial evaluation?

PICO #2: In adults with non-traumatic neck pain, when is XR required as the initial imaging modality for optimal patient management?

PICO #3: In adults with non-traumatic neck pain, what is the role of Computed Tomography (CT) imaging modalities for optimal management?

PICO #4: In adults with non-traumatic neck pain, what clinical findings warrant Magnetic Resonance (MR) imaging for optimal management?

PICO #5: In adults with non-traumatic neck pain in whom there is a concern for pathologic fracture, when should MR be performed compared to other imaging modalities for optimal diagnostic assessment?

PICO #6: In adults with non-traumatic radicular neck pain, which imaging modality is preferred to facilitate interventional pain management procedures?

PICO #1: In adults with non-traumatic neck pain, is imaging always warranted for initial evaluation?

SEMPI Grading QOE – Table 1B.1a – Summary of Findings						
PICO #1: In adults with non-traumatic neck pain, is imaging always warranted for initial evaluation?						
Author/Year/Title	Design	Population	Intervention Vs Comparator	Results	Conclusion Summary	SEMPI QOE Rating
Lin et al., 2019 What does best practice care for musculoskeletal pain look like? Eleven consistent recommendations from high-quality clinical practice guidelines: systematic review	Systematic review	44 CPG's appraised	NA	Guidelines discouraged routine use of radiologic imaging. Patients should be screened to identify those with a higher likelihood of serious pathology or red flag conditions. Consideration of imaging if there is "suspicion of an underlying anatomical anomaly, such as spondylolisthesis, moderate to severe spondylosis" or "mechanical instability"	Imaging should be used for following: -Serious pathology suspected -Unexplained progression of symptoms, failure of conservative management -Imaging is likely to change management	Moderate
Nordin et al., 2018 The Global Spine Care Initiative: a systematic review for the assessment of spine-related complaints in populations with limited resources and in low-and middle-income communities	Systematic review of clinical guidelines	20 guidelines reviewed, 13 used (neck and back pain)	Physical examination, XR, MR, CT	Signs/Symptoms ("red flags") indicators for imaging in non-traumatic neck pain patients: -Hx of Trauma -Hx of Cancer Nerve compression/disorders (e.g., herniated disc with radiculopathy) • Radiculopathy symptoms present >1 month • Severe/progressive neurologic deficits, progressive motor weakness Spinal stenosis • Radiation leg pain • Older age • Pain usually relieved with sitting • Pseudoclaudication a weak predictor • Spinal stenosis symptoms present > 1 month Myelopathy • Pain and stiffness in the neck • Heavy feeling in the legs • Inability to walk at a brisk pace	Diagnostic imaging should be performed only when serious disease processes are suspected and/ or there is progressive neurologic deficit or worsening symptom severity, unresponsive to conservative management ("red flags")	Moderate

				• Deterioration in fine motor skills (such as handwriting or buttoning a shirt) • Intermittent shooting pains into the arms and legs (like an electrical shock), especially when bending their head forward		
Leichtle et al., 2015 Spine radiography in the evaluation of back and neck pain in an orthopaedic emergency clinic	Retrospective study	Adult patients with acute neck or back pain (484 patients), N=77 had cervical X-ray. Didn't exclude traumatic.	Analyze and optimize diagnostics and treatment	338 (70%) cases had radiography performed: Normal – 142 patients (42%) Degenerative changes -123 patients (36%) Metastatic disease at C7-1 Post-traumatic C1-C2 instability -1	Plain radiography of the spine was unnecessary in most patients initially evaluated with non- specific acute back pain and without sensorimotor deficits	Low
Initial QOE Score Across Studies for PICO #1: **Moderate (2)**						

SEMPI Grading QOE – Table 1B.1b – Risk of Bias		
PICO #1: In adults with non-traumatic neck pain, is imaging always warranted for initial evaluation?		
Evaluate Outcome for Risk of Bias Across Studies		
Initial QOE Score Across Studies for PICO: **MODERATE**		
Criteria	**Assessment**	**Reason for Assessment**
Negative Bias		
Risk of Bias	Serious	Only one study (retrospective), review and guidelines, no comparative data
Inconsistency	Not Serious	
Indirectness	Serious	Above articles are not specific to non-traumatic neck pain (include other MSK pain, traumatic neck pain, lower back pain)
Imprecision	Not Serious	
Positive Bias		
Strength of Association	Low	
Other Considerations	No	
Overall Effect of Bias on Initial QOE Grade: Downgraded to Low		
Final QOE Grade for Outcome Across Studies: **LOW**		
High – Very confident the true effect lies close to that of the estimate of the effect **Moderate** – Moderately confident in the effect estimate (the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different) **Low** – Confidence in the effect estimate is limited (the true effect may be substantially different from the estimate of effect) **Very Low** – Very little confidence in the effect estimate (the true effect is likely to be substantially different from the estimate of effect)		

SEMPI Grading QOE – Table 1B.1c – Evidence to Recommendations				
PICO #1: In adults with non-traumatic neck pain, is imaging always warranted for initial evaluation?				
SEMPI Quality of Evidence (QOE) & Recommendation Strength				
Author/Year/Title	Highlights	SEMPI QOE Category	Final QOE Category	Recommendation Strength
Lin et al., 2019 What does best practice care for musculoskeletal pain look like? Eleven consistent recommendations from high-quality clinical practice guidelines: systematic review	Imaging should be used for following: -Serious pathology suspected -Unexplained progression of symptoms, failure of conservative management -Imaging is likely to change management	Moderate	Low (3)	Strong (A)
Nordin et al., 2018 The Global Spine Care Initiative: a systematic review for the assessment of spine-related complaints in populations with limited resources and in low-and middle-income communities	Diagnostic imaging should be performed only when serious disease processes are suspected and/ or there is progressive neurologic deficit or worsening symptom severity, unresponsive to conservative management ("red flags")	Moderate		
Leichtle et al., 2015 Spine radiography in the evaluation of back and neck pain in an orthopaedic emergency clinic	Plain radiography of the spine is not recommended in all patients suffering from non-specific acute neck pain	Low		
Recommendation Rating: 3A—Strong recommendation for the intervention based on low quality evidence **Justification:** Widespread consensus-based agreement across guidelines, however, there were few clinical studies to rely on.				
Rating Definitions: **Quality of Evidence:** High quality =**1**; Moderate quality = **2**; Low quality = **3**; Very low quality = **4** **Strength of Recommendation: A** = Strength of Recommendation from Consistent Evidence; **B**=Strength of Recommendation from Panel Consensus				

Conclusion: A detailed physical examination and history can identify individuals who require imaging from those who do not warrant imaging. Radiological imaging is discouraged in patients with neck pain unless serious pathology is suspected; or there has been an unsatisfactory response to conservative care/progression of signs and symptoms; or imaging is likely to change management (Lin et al., 2019; Nordin et al., 2018). The following red flags have been identified (Cohen, 2015):

- Trauma
- Rheumatoid arthritis. Down syndrome, spondyloarthropathy
- Constitutional symptoms
- Infectious symptoms
- Upper motor neuron lesion
- Age <20 y
- Concurrent chest pain, diaphoresis or shortness of breath
- Age >50 y

Final Recommendation: 3A—In adults who present with non-traumatic neck pain, initial imaging is not warranted in the absence of "red flag" symptoms.

PICO #2: In adults with non-traumatic neck pain, when is XR required as the initial imaging modality for optimal patient management?

SEMPI Grading QOE – Table 1B.2a – Summary of Findings						
PICO #2: In adults with non-traumatic neck pain, when is XR required as the initial imaging modality for optimal patient management?						
Author/Year/Title	Design	Population	Intervention Vs Comparator	Results	Conclusion Summary	SEMPI QOE Rating
Nordin et al., 2018 The Global Spine Care Initiative: a systematic review for the assessment of spine-related complaints in populations with limited resources and in low-and middle-income communities	Systematic Review of Current Guidelines International Global Spine Care Initiative (Canada, Europe, India, Turkey, USA)	3069 citations, 20 guidelines reviewed and 13 were used for new recommendations	NA	Signs/Symptoms ("red flags) indicators for imaging in non-traumatic neck pain patients: -Hx of Trauma -Hx of Cancer Nerve compression/disorders (e.g., herniated disc with radiculopathy) • Radiculopathy symptoms present >1 month • Severe/progressive neurologic deficits, progressive motor weakness Spinal stenosis • Radiation leg pain • Older age • Pain usually relieved with sitting • Pseudo-claudication a weak predictor • Spinal stenosis symptoms present > 1 month Myelopathy • Pain and stiffness in the neck • Heavy feeling in the legs • Inability to walk at a brisk pace • Deterioration in fine motor skills (such as handwriting or buttoning a shirt) • Intermittent shooting pains into the arms and legs (like an electrical shock), especially when bending their head forward	Diagnostic imaging should be performed only when serious disease processes are suspected and/ or there is progressive neurologic deficit or worsening symptom severity, unresponsive to conservative management ("red flags")	Moderate

Guzman et al., 2009 Clinical practice implications of the bone and joint decade 2000-2010 task force on neck pain and its associated disorders	Guidelines based on systematic review	552 articles 4 research projects	N/A	Neck pain patients should be triaged based on history and physical exam, including screening for red flags, signs of radiculopathy. Presence of red flags or radiculopathy warrant imaging For non-traumatic neck pain Grade 1 or 2 X-ray not helpful, and for Grade 3 MRI if red flags	Presence of red flags warrant diagnostic evaluation	Moderate
Kaptoge et al., 2004 When should the doctor order a spine x-ray? Identifying vertebral fractures for osteoporosis care	Prospective registry data	2908 females, 2653 males-- All over 50 years of age	Thoracic and lumbar XR	Relative Risk Age-RR, 1.67 [95% CI, 1.46, 1.93] per decade Self-reported history of spine fracture 7.52 [95% CI, 5.52, 10.23]	Women, aged 65 years and older with a history of vertebral fracture, have a 25% chance of another fracture and X-ray imaging can facilitate rapid screening	Moderate
Initial QOE Score Across Studies for PICO #2: **Moderate (2)**						

SEMPI Grading QOE – Table 1B.2b – Risk of Bias		
PICO #2: In adults with non-traumatic neck pain, when is XR required as the initial imaging modality for optimal patient management?		
Evaluate Outcome for Risk of Bias Across Studies		
Initial QOE Score Across Studies for PICO: MODERATE		
Criteria	**Assessment**	**Reason for Assessment**
Negative Bias		
Risk of Bias	Serious	Paucity of literature, review and guidelines, no comparative data
Inconsistency	Serious	Significant heterogeneity
Indirectness	Serious	Articles not specifically looking at non-traumatic neck pain
Imprecision	Not Serious	
Positive Bias		
Strength of Association	Low	
Other Considerations	No	
Overall Effect of Bias on Initial QOE Grade: Downgraded to Low		
Final QOE Grade for Outcome Across Studies: **LOW**		
High – Very confident the true effect lies close to that of the estimate of the effect **Moderate** – Moderately confident in the effect estimate (the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different) **Low** – Confidence in the effect estimate is limited (the true effect may be substantially different from the estimate of effect) **Very Low** – Very little confidence in the effect estimate (the true effect is likely to be substantially different from the estimate of effect)		

SEMPI Grading QOE – Table 1B.2c – Evidence to Recommendations

PICO #2: In adults with non-traumatic neck pain, when is XR required as the initial imaging modality for optimal patient management?

SEMPI Quality of Evidence (QOE) & Recommendation Strength

Author/Year/Title	Highlights	SEMPI QOE Rating	Final QOE Category	Recommendation Strength
Nordin et al., 2018 The Global Spine Care Initiative: a systematic review for the assessment of spine-related complaints in populations with limited resources and in low-and middle-income communities	Diagnostic imaging should be performed only when serious disease processes are suspected and/ or there is progressive neurologic deficit or worsening symptom severity, unresponsive to conservative management ("red flags")	Moderate	Low (3)	Strong (A)
Guzman et al., 2009 Clinical practice implications of the bone and joint decade 2000-2010 task force on neck pain and its associated disorders	Presence of red flags warrant diagnostic evaluation	Moderate		
Kaptoge et al., 2004 When should the doctor order a spine X-ray? Identifying vertebral fractures for osteoporosis care	Women, aged 65 years and older with a history of vertebral fracture, have a 25% chance of another fracture and X-ray imaging can facilitate rapid screening	Moderate		

Recommendation Rating:3A—Strong recommendation for the intervention based on low quality evidence
Justification: Lack of clinical trials led to downgrading the evidence, agreement is consistent for imaging in adults with red flag symptoms with XR as a baseline/screening modality thereby leading to a strong recommendation.

Rating Definitions:

Quality of Evidence: High quality =**1**; Moderate quality = **2**; Low quality = **3**; Very low quality = **4**
Strength of Recommendation: A = Strength of Recommendation from Consistent Evidence; **B**=Strength of Recommendation from Panel Consensus

Conclusions: Spine X-rays provide detailed images of the bones of the spine and generally include 3 standard views: AP (anteroposterior), or frontal view; lateral (side view); and a third view "open mouthed" that allows visualization of odontoid or dens. Conditions may be seen in spine x-rays include fractures, tumors, infection and arthritis. Cervical spine x-rays are often used to detect small fractures or misalignment of the vertebrae. They may indicate the degree of degeneration, but do not provide information about the discs themselves. XR is the screening modality of choice for evaluating spinal surgery post-operatively because of the lack of artifact produced by the hardware used (Thakkar et al., 2012). Radiographs are cost effective, easily accessible and provide a baseline for further imaging.

Final Recommendation:3A—In adults presenting with non-traumatic neck pain, XR of the cervical spine is recommended for the following:

- Suspicion of fracture (history of osteoporosis)
- History of malignancy
- Previous/remote/ history of cervical trauma
- Persistent or worsening symptoms despite conservative management/usual care
- Concern for systemic illness (e.g. osteomyelitis, rheumatoid arthritis)
- Initial evaluation of cervical spine procedures post-operatively

PICO #3: In adults with non-traumatic neck pain, what is the role of Computed Tomography (CT) imaging modalities for optimal management?

SEMPI Grading QOE – Table 1B.3a – Summary of Findings						
PICO #3: In adults with non-traumatic neck pain, what is the role of Computed tomography (CT) imaging modalities for optimal management?						
Author/Year/Title	Design	Population	Intervention Vs Comparator	Results	Conclusion Summary	SEMPI QOE Rating
Waly et al., 2017 Preoperative computed tomography myelography parameters as predictors of outcome in patients with degenerative cervical myelopathy: Results of a systematic review	Systematic Review- determine the preoperative CT myelography (CT-M) imaging parameters in degenerative cervical myelopathy that correlate with severity and predict postoperative functional outcome	N=5 studies (402 patients), all retrospective cohort studies Included studies published 1989-2005.	NA	CT-M parameters evaluated: transverse area of the spinal cord at maximum level of compression, spinal canal narrowing, number of blocks, spinal canal diameter, and flattening ratio evaluated. Preoperative transverse area of the spinal cord greater than 30 mm^2 is the only parameter that predicts better postoperative functionality. No parameters found that correlate with severity	CT myelography plays a complementary role for diagnosing degenerative cervical myelopathy in patients who cannot undergo MR, and it may help assist surgeons in deciding the most appropriate treatment strategy.	Moderate
Abiola, Rubery & Mesfin, 2016 Ossification of the posterior longitudinal ligament: etiology, diagnosis, and outcomes of nonoperative and operative management	Review	NA	NA	CT scan sagittal sequences can help classify the type of OPLL. It has higher intra-observer reliability than does XR. XR has low inter-and intra-observer reliability for diagnosing POPLL as compared to CT. MRI is useful for detecting myelomalacia and extent of spinal cord compression and for foraminal stenosis that could be contributing to myelopathy	CT localizes the ossification lesion to a central or paracentral location, which facilitates the preoperative planning	Low
Joaquim et al., 2015 Radiological evaluation of cervical spine involvement in rheumatoid arthritis	Review	NA	NA	CT scan can precisely document the position of the odontoid with respect to the foramen magnum, the degree of atlantoaxial dislocation, and the relationships among the upper cervical spine joints	CT scan with multiplanar reconstruction is the method of choice for detailed bony evaluation (including	Low

				Contrast-enhanced CT scan can be useful to diagnose inflammatory soft tissue proliferation in patients unable to undergo MRI CT scans can demonstrate occult instabilities, especially in the cranio-cervical and cervicothoracic regions that are poorly visualized by flexion-extension plain radiographs due to superimposed bony structures XR best for screening MRI is most sensitivity modality for detection of cervical spine involvement in RA and should be performed in all patients with anomalies detecting or suspected on plain radiographs	visualization of erosions, anatomy, and the presence of ankylosis and pseudarthrosis)	
Chanplakorn et al., 2014 Morphometric evaluation of subaxial cervical spine using multi-detector computerized tomography (MD-CT) scan: the consideration for cervical pedicle screws fixation	Retrospective study	N=74 patients (740 pedicles)	MDCT	For stabilizing the cervical spine, transpedicular screw fixation provides the greatest stability and measurement of pedicle dimensions and adjacent neurovascular structures enhances the safety of transpedicular screw insertion.	The entry point and trajectories for cervical pedicle screw insertion should be determined individually by using pre-operative Multidetector CT (MDCT) scan.	Low
Kudo et al., 2013 Interobserver and intraobserver reliability of the classification and diagnosis for ossification of the posterior longitudinal ligament of the cervical spine	Observational study	57 patients, 16 observers interobserver and intraobserver reliability of the classification and diagnosis for cervical OPLL by radiographs and CT images	XR vs CT images	Intra-observer reliability of the diagnosis was 0.613 (specialists 0.690, residents 0.537) with radiographs only and 0.802 (specialists 0.795, residents 0.808) using radiographs and CT images.	Adding CT to XR increased reliability. The reliability of the classification and diagnosis for cervical Ossification of Posterior Longitudinal Ligament (OPLL) improves with additional CT images. Authors propose diagnostic criteria for OPLL include both XR and CT.	Moderate
Initial QOE Score Across Studies for PICO #3: **Moderate (2)**						

SEMPI Grading QOE – Table 1B.3b – Risk of Bias		
PICO #3: In adults with non-traumatic neck pain, what is the role of Computed tomography (CT) imaging modalities for optimal management?		
Evaluate Outcome for Risk of Bias Across Studies		
Initial QOE Score Across Studies for PICO: **MODERATE**		
Criteria	**Assessment**	**Reason for Assessment**
Negative Bias		
Risk of Bias	Serious	Small sample size, selective reporting, non-randomized, review articles
Inconsistency	Serious	Heterogenous literature
Indirectness	Serious	CT and CT-M literature not clearly identified for its application in different clinical settings
Imprecision	Not Serious	
Positive Bias		
Strength of Association	Low	
Other Considerations	No	
Overall Effect of Bias on Initial QOE Grade: Downgraded to Low		
Final QOE Grade for Outcome Across Studies: **LOW**		
High – Very confident the true effect lies close to that of the estimate of the effect **Moderate** – Moderately confident in the effect estimate (the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different) **Low** – Confidence in the effect estimate is limited (the true effect may be substantially different from the estimate of effect) **Very Low** – Very little confidence in the effect estimate (the true effect is likely to be substantially different from the estimate of effect)		

SEMPI Grading QOE – Table1B.3c – Evidence to Recommendations				
PICO #3: In adults with non-traumatic neck pain, what is the role of Computed Tomography (CT) imaging modalities for optimal management?				
SEMPI Quality of Evidence (QOE) & Recommendation Strength				
Author/Year/Title	Highlights	SEMPI QOE Category	Final QOE Category	Recommendation Strength
Waly et al., 2017 Preoperative computed tomography myelography parameters as predictors of outcome in patients with degenerative cervical myelopathy: Results of a systematic review	CT myelography plays a complementary role for diagnosing degenerative cervical myelopathy in patients who cannot undergo MR, and it may help assist surgeons in deciding the most appropriate treatment strategy.	Moderate	Low (3)	Strong (A)
Abiola, Rubery & Mesfin, 2016 Ossification of the posterior longitudinal ligament: etiology, diagnosis, and outcomes of nonoperative and operative management	CT localizes the ossification lesion to a central or paracentral location, which facilitates the preoperative planning	Low		
Joaquim et al., 2015 Radiological evaluation of cervical spine involvement in rheumatoid arthritis	CT scan with multiplanar reconstruction is the method of choice for detailed bony evaluation (including visualization of erosions, anatomy, and the presence of ankylosis and pseudarthrosis)	Low		
Chanplakorn et al., 2014 Morphometric evaluation of subaxial cervical spine using multi-detector computerized tomography (MD-CT) scan: the consideration for cervical pedicle screws fixation	The entry point and trajectories for cervical pedicle screw insertion should be determined individually by using pre-operative Multidetector CT (MDCT) scan.	Low		
Kudo et al., 2013 Interobserver and intraobserver reliability of the classification and diagnosis for ossification of the posterior longitudinal ligament of the cervical spine	The reliability of the classification and diagnosis for cervical Ossification of Posterior Longitudinal Ligament (OPLL) improves with additional CT images.	Moderate		
Recommendation Rating: 3A—Strong recommendation for the intervention based on low quality evidence **Justification:** Paucity of literature and inclusion of review articles led to downgrading the evidence. However, CT being the modality of choice for bony evaluation, warrants a strong recommendation.				

Rating Definitions:

Quality of Evidence: High quality =**1**; Moderate quality = **2**; Low quality = **3**; Very low quality = **4**

Strength of Recommendation: A = Strength of Recommendation from Consistent Evidence; **B**=Strength of Recommendation from Panel Consensus

Conclusion: Computed Tomography (CT) imaging is the method of choice for detailed bony evaluation (including visualization of erosions, anatomy, and the presence of ankylosis and pseudarthrosis) as well as ossification of ligamentous structures. It can be useful where bony anatomy is critical or in surgical planning (e.g. entry point and trajectories for cervical pedicle screw insertion). The best radiological modality for evaluating bone anatomy is 3D CT with multiplanar reconstruction that can precisely document the position of the odontoid with respect to the foramen magnum, the degree of atlantoaxial dislocation, and the relationships among the upper cervical vertebrae (Joaquim et al., 2015). CT-myelography (CT-M) plays a complementary role for diagnosing degenerative cervical myelopathy in patients who cannot undergo magnetic resonance (MR) imaging. Specifically, CT-M facilitates perioperative planning by measuring the transverse area of the spinal cord at the maximum level of compression, spinal canal narrowing/diameter and flattening ratios. It can predict postoperative functionality.

Final Recommendations: 3A—In adults with non-traumatic neck pain CT imaging is recommended for detailed osseous (bone) evaluation and surgical planning (particularly when fixation/implantation is planned). CT with IV contrast can also be used to evaluate for suspected malignancy or infection in patients with contraindications to MR examinations. CT-myelography (CT-M) is a complementary imaging modality used in conjunction with other imaging modalities to differentiate bony from soft-tissue structures and assist with perioperative planning.

PICO #4: In adults with non-traumatic neck pain, what clinical findings warrant Magnetic Resonance (MR) imaging for optimal management?

SEMPI Grading QOE – Table 1B.4a – Summary of Findings						
PICO #4: In adults with non-traumatic neck pain, what clinical findings warrant Magnetic Resonance (MR) imaging for optimal management?						
Author/Year/Title	Design	Population	Intervention Vs Comparator	Results	Conclusion Summary	SEMPI QOE Rating
Davies et al., 2018 Degenerative cervical myelopathy	Case report and Literature Review	Degenerative cervical myelopathy (DCM)	NA	Incidental cervical cord compression is common in asymptomatic adults (32%--5th decade, 67%--8th decade) Signs & Symptoms: neck pain/stiffness, upper/lower limb weakness, numbness, stiffness, paresthesia, imbalance, falls, incontinence, upper limb extensor/lower limb flexor weakness, hyperreflexia, spasticity, clonus, Babinski and Hoffman signs present	Magnetic resonance (MR) imaging is required to provide anatomic detail of degenerative cervical spine changes and cord compression but must correlate with physical exam findings	Low
Lener et al., 2018 Management of spinal infection: a review of the literature	Review	NA	NA	Magnetic resonance imaging is the most reliable method to diagnose spondylodiscitis, due to its high sensitivity (96%), high specificity (94%), and capability to provide detailed data on paraspinal tissues and the epidural space	MR is the most reliable imaging modality to diagnose and identify location (i.e., intraspinal, intervertebral, paraspinal) spinal infection	Low

Nouri et al., 2015 Role of magnetic resonance imaging in predicting surgical outcome in patients with cervical spondylotic myelopathy	Prospective & Retrospective using data from AO Spine SSM-North American multicenter study which was collected prospectively	102 patients with complete MR analysis and 90 with complete follow up, all of whom underwent cervical spinal decompressive surgery	MR	T1 signal hypo intensity: Odds Ratio 0.242; CI 95% (0.068-0.866) MCC (Maximum Canal Compromise): Odds Ratio 0.940; CI 95% (0.900-0.982)	Magnetic resonance (MR) can predict post-surgical outcome in patients with cervical spondylotic myelopathy	Moderate
Bono et al., 2011 An evidence-based clinical guideline for the diagnosis and treatment of cervical radiculopathy from degenerative disorders	Evidence-based clinical guideline of North American Spine Society (NASS)	Adult surgical candidates with back pain	MR	Confirmation of correlative compressive lesions (disc herniation and spondylosis) in cervical spine patients	Magnetic resonance (MR) imaging can confirm compressive cervical spine lesions (disc herniation and spondylosis) in patients that have failed conservative management and may be offered surgery or other interventional treatment	Moderate
Guzman et al., 2009 Clinical Practice Implications of the Bone and Joint Decade 2000-2010 Task Force on Neck Pain and its Associated Disorders	Literature review and clinical guideline review by Bone and Joint Task Force	Adult surgical candidates with neck pain	MR	MR imaging should be considered in: - severe incapacitating radicular pain - new neurologic deficits on exam - progression/worsening of neurologic deficits	Magnetic resonance (MR) imaging in conjunction with physical exam can detect the site and level of cervical nerve root/spinal cord compression in adults with neck pain	Moderate
Initial QOE Score Across Studies for PICO #4: **Moderate (2)**						

SEMPI Grading QOE – Table 1B.4b – Risk of Bias		
PICO #4: In adults with non-traumatic neck pain, what clinical findings warrant Magnetic Resonance (MR) imaging for optimal management?		
Evaluate Outcome for Risk of Bias Across Studies		
Initial QOE Score Across Studies for PICO: **MODERATE**		
Criteria	**Assessment**	**Reason for Assessment**
Negative Bias		
Risk of Bias	Serious	Guidelines and literature reviews included lack of trial studies
Inconsistency	Serious	Heterogeneous literature
Indirectness	Not Serious	
Imprecision	Not Serious	
Positive Bias		
Strength of Association	Low	No direct comparisons, doesn't apply
Other Considerations	No	
Overall Effect of Bias on Initial QOE Grade: Downgraded to LOW		
Final QOE Grade for Outcome Across Studies: **LOW**		
High – Very confident the true effect lies close to that of the estimate of the effect **Moderate** – Moderately confident in the effect estimate (the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different) **Low** – Confidence in the effect estimate is limited (the true effect may be substantially different from the estimate of effect) **Very Low** – Very little confidence in the effect estimate (the true effect is likely to be substantially different from the estimate of effect)		

SEMPI Grading QOE – Table 1B.4c – Evidence to Recommendations

PICO #4: In adults with non-traumatic neck pain, what clinical findings warrant Magnetic Resonance (MR) imaging for optimal management?

SEMPI Quality of Evidence (QOE) & Recommendation Strength

Author/Year/Title	Highlights	SEMPI QOE Rating	Final QOE Category	Recommendation Strength
Davies et al., 2018 Degenerative cervical myelopathy	Magnetic resonance (MR) imaging is required to provide anatomic detail of degenerative cervical spine changes and cord compression but must correlate with physical exam findings	Low	Low (3)	Strong (A)
Lener et al., 2018 Management of spinal infection: a review of the literature	MR is the most reliable imaging modality to diagnose and identify location (i.e., intraspinal, intervertebral, paraspinal) spinal infection	Low		
Nouri et al., 2015 Role of magnetic resonance imaging in predicting surgical outcome in patients with cervical spondylotic myelopathy	Magnetic resonance (MR) can predict post-surgical outcome in patients with cervical spondylotic myelopathy	Moderate		
Bono et al., 2011 An evidence-based clinical guideline for the diagnosis and treatment of cervical radiculopathy from degenerative disorders	Magnetic resonance (MR) imaging can confirm compressive cervical spine lesions (disc herniation and spondylosis) in patients that have failed conservative management and may be offered surgery or other interventional treatment	Moderate		
Guzman et al., 2009 Clinical Practice Implications of the Bone and Joint Decade 2000-2010 Task Force on Neck Pain and its Associated Disorders	Magnetic resonance (MR) imaging in conjunction with physical exam can detect the site and level of cervical nerve root compression in adults with neck pain	Moderate		

Recommendation Rating: 3A—Strong recommendation for the intervention based on low quality evidence
Justification: Paucity of recent trial-based literature warrants downgrading the evidence. MR imaging is considered the gold standard based on professional society guidelines for cervical radiculopathy/myelopathy.

Rating Definitions:

Quality of Evidence: High quality =**1**; Moderate quality = **2**; Low quality = **3**; Very low quality = **4**

Strength of Recommendation: A = Strength of Recommendation from Consistent Evidence; **B**=Strength of Recommendation from Panel Consensus

Conclusion: Degenerative myelopathy is the most common cause of nontraumatic impairment of the cervical spinal cord in adults (Witiw & Fehlings, 2017). Degenerative cervical myelopathy comprises age-related pathologies of the cervical spinal column that lead to myelopathy from compression of the spinal cord. These include osteoarthritic degeneration (cervical spondylosis) and ligamentous aberrations. Similarly, cervical radiculopathy can be traced to compression of specific nerve roots in the cervical spine by the same age-related processes. Cross-sectional imaging with magnetic resonance (MR) is needed to provide anatomic detail of such lesions, but **clinical exam correlations are mandatory** given the high prevalence of asymptomatic degenerative changes found in the cervical spine across a wide age bracket (Nakashima et al., 2015).

Final Recommendations: 3A--In adults with non-traumatic neck pain, magnetic resonance (MR) imaging is recommended in the following clinical scenarios for optimal patient management:

- New-onset neurologic deficit(s) in patients with suspected degenerative cervical radiculopathy/myelopathy
- Progressive/worsening neurologic deficits
- Peri-operative prognostic evaluation

MR with IV contrast can also be used to evaluated for suspected malignancy or infection in patients without contraindications to MR examinations.

PICO #5: In adults with non-traumatic neck pain in whom there is a concern for pathologic fracture, when should MR be performed compared to other imaging modalities for optimal diagnostic assessment?

SEMPI Grading QOE – Table 1B.5a – Summary of Findings						
PICO #5: In adults with non-traumatic neck pain in whom there is a concern for pathologic fracture, when should MR be performed compared to other imaging modalities for optimal diagnostic assessment?						
Author/Year/Title	Design	Population	Intervention Vs Comparator	Results	Conclusion Summary	SEMPI QOE Rating
Li et al., 2018 A novel MRI-and CT-based scoring system to differentiate malignant from osteoporotic vertebral fractures in Chinese patients	MR, CT scoring system for vertebral fx's Assessed 15 image (CT/MR) findings for distinguishing osteoporotic vertebral fxs (OVF)and metastatic vertebral fxs (MVF)	150 OVFs 150 MVFs in 226 patients over 5 year 15 findings: 12 (MR) and 3 (CT) Imaging done within 2 months of presumed fracture Thoraco-lumbar only 2 surgeons + 1 radiologists	MR, CT findings to differentiate OVFs and MVFs Pathology specimen from open surgical or percutaneous bx-MVF (ref standard) and same or improved symptoms and normalization of MR--OVF	Stepwise "discriminant analysis" used to create a novel scoring system to differentiate MVF vs OVF by MR, CT 15 imaging findings had "discriminant accuracy" of 98.3%; data converted to scoring system: 4 or greater=MVF and 3 or less= OVF with classification accuracy of 98.3%	Findings on both CT and MR imaging can be used to distinguish between metastatic versus osteoporotic vertebral fractures in the thoracolumbar spine	Low
Yueniwat & Widhiasi, 2015 Role of magnetic resonance imaging in differentiating spondylitis from vertebral metastasis.	Retrospective study	35 cases of histologic-proven samples—13 metastatic lesions, 22 spondylotic lesions	MR imaging (histology as reference standard)	19/22 samples (86%) of histologic spondylitis were diagnosed as spondylotic lesions on MR 13/13 samples (100%) of histologic metastasis were diagnosed as metastatic lesions on MR	MR is an accurate modality for assessing vertebrae and their disorders. MR is more precise in diagnosing metastasis versus spondylosis. involvement of the anterior posterior vertebral component, paravertebral mass, and skip lesions denote changes due to metastatic lesions	Low

Li & Poon, 1988 Sensitivity and specificity of MRI in detecting malignant spinal cord compression and in distinguishing malignant from benign compression fractures of vertebrae	Retrospective observational cohort	75 patients with a collapsed vertebral body known to be metastatic in nature	MR vs CT vs myelogram with surgical biopsy as reference standard	MR sensitivity= 93% specificity= 95% positive predictive value=98%, negative predictive value=91% 2 false positives and 2 false negatives One false negative was a patient who had thoracic and lumbar MRI but declined cervical MRI who later developed quadriplegia and was found to have cervical cord compression	Magnetic resonance (MR) imaging can reliably detect metastatic vertebral fractures complicated by spinal cord compression	Moderate
Initial QOE Score Across Studies for PICO #5: **Low (3)**						

SEMPI Grading QOE – Table 1B.5b – Risk of Bias		
PICO #5: In adults with non-traumatic neck pain in whom there is a concern for pathologic fracture, when should MR be performed compared to other imaging modalities for optimal diagnostic assessment?		
Evaluate Outcome for Risk of Bias Across Studies		
Initial QOE Score Across Studies for PICO: **LOW**		
Criteria	**Assessment**	**Reason for Assessment**
Negative Bias		
Risk of Bias	Serious	Pre-selected patient cohorts
Inconsistency	Serious	Heterogenous literature
Indirectness	Not Serious	
Imprecision	Not Serious	
Positive Bias		
Strength of Association	Moderate	Histopathologic and surgical biopsy confirmation
Other Considerations	No	
Overall Effect of Bias on Initial QOE Grade: No Change		
Final QOE Grade for Outcome Across Studies: **LOW**		
High – Very confident the true effect lies close to that of the estimate of the effect **Moderate** – Moderately confident in the effect estimate (the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different) **Low** – Confidence in the effect estimate is limited (the true effect may be substantially different from the estimate of effect) **Very Low** – Very little confidence in the effect estimate (the true effect is likely to be substantially different from the estimate of effect)		

SEMPI Grading QOE – Table 1B.5c – Evidence to Recommendations

PICO #5: In adults with non-traumatic neck pain in whom there is a concern for pathologic fracture, when should MR be performed compared to other imaging modalities for optimal diagnostic assessment?

SEMPI Quality of Evidence (QOE) & Recommendation Strength

Author/Year/Title	Highlights	SEMPI QOE Rating	Final QOE Category	Recommendation Strength
Li et al., 2018 A novel MRI-and CT-based scoring system to differentiate malignant from osteoporotic vertebral fractures in Chinese patients	Findings on both CT and MR imaging can be used to distinguish between metastatic versus osteoporotic vertebral fractures in the thoracolumbar spine	Low	Low (3)	Strong (A)
Yueniwat & Widhiasi, 2015 Role of magnetic resonance imaging in differentiating spondylitis from vertebral metastasis	MR is an accurate modality for assessing vertebrae and their disorders. MR is more precise in diagnosing metastasis versus spondylosis. involvement of the anterior posterior vertebral component, paravertebral	Low		
Li & Poon, 1988 Sensitivity and specificity of MRI in detecting malignant spinal cord compression and in distinguishing malignant from benign compression fractures of vertebrae	MR is useful to detect metastasis despite not being sensitive as CT-myelography because it is less invasive	Moderate		

Recommendation Rating: 3A—Strong recommendation for the intervention based on low quality evidence

Justification: Despite significance bias in literature, positive histopathologic and surgical biopsy confirmation led to no change in the quality of evidence.

Rating Definitions:

Quality of Evidence: High quality =**1**; Moderate quality = **2**; Low quality = **3**; Very low quality = **4**

Strength of Recommendation: A = Strength of Recommendation from Consistent Evidence; **B**=Strength of Recommendation from Panel Consensus

Conclusion: Nontraumatic vertebral fractures are relatively common and often attributed to osteoporosis, particularly in older women. Malignancy and infection, however, can also underlie vertebral fractures and early detection is critical for optimal management. Although plain radiography (XR) is the initial imaging modality when vertebral fracture is suspected, it often cannot differentiate between osteoporosis, infection, or metastatic/primary malignancy as the underlying etiology. Similarly, computed tomography (CT) imaging can identify cortical bone destruction, but magnetic resonance (MR) imaging is often best at distinguishing neoplastic from osteoporotic vertebral fractures (Cicala et al., 2013). MR imaging is considered the reference standard for metastatic cervical spine lesions given its ability to visualize the bone-soft tissue interface and thus identifying invasion/compression of a bone and neural structures (Molina et al., 2012).

Final Recommendations: 3A—In adults with nontraumatic cervical/neck pain in whom there is a concern for vertebral pathologic fracture, magnetic resonance (MR) imaging is recommended for optimal diagnostic assessment.

PICO #6: In adults with non-traumatic radicular neck pain, which imaging modality is preferred to facilitate interventional pain management procedures?

SEMPI Grading QOE – Table 1B.6a – Summary of Findings						
PICO #6: In adults with non-traumatic radicular neck pain, which imaging modality is preferred to facilitate interventional pain management procedures?						
Author/Year/Title	Design	Population	Intervention Vs Comparator	Results	Conclusion Summary	SEMPI QOE Rating
Amrhein et al., 2017 Incidence of Inadvertent Dural Puncture During CT Fluoroscopy-Guided Interlaminar Epidural Corticosteroid Injections in the Cervical Spine: An Analysis of 974 Cases	Retrospective observational study	N=728 patients (974 cervical interlaminar ESI's)	CT FL-guided and conventional fluoroscopy techniques for interlaminar ESI's	**CT- Fluro:** Inadvertent dural punctures identified in 14 of 974 needle placements (1.4%) Rate of inadvertent intravascular injection -4.6% Complication rate 0.4% **Fluoroscopy:** Inadvertent dural puncture 0% - 2.7%	Inadvertent dural puncture rate is similar to previously reported rates for conventional fluoroscopy (limited to the lower cervical spine only) CT fluoroscopy– guided cervical interlaminar epidural injections can be performed at all levels throughout the cervical spine	Low
Park et al., 2017 Ultrasound versus fluoroscopy-guided cervical medial branch block for the treatment of chronic cervical facet joint pain: a retrospective comparative study.	Retrospective observational study	126	Effectiveness and safety between US-guided and FL-guided CMBBs (cervical medial branch block) techniques for the treatment of cervical facet joint	Significant improvements in pain reduction for all subjects ($p < 0.05$) in both FL and US groups. Administration duration (221 vs. 383 s) and # of needle passes (2 vs 5) were significantly less in the US-guided group ($p < 0.001$).	Fluoroscopy-guided and Ultrasound-guided cervical medial branch blocks provide similar pain relief and functional improvements. US-guided branch blocks require less time and fewer needle passes.	Low

Jee et al., 2013 Ultrasound-guided selective nerve root block versus fluoroscopy-guided transforaminal block for the treatment of radicular pain in the lower cervical spine: a randomized, blinded, controlled study	Randomized prospective blinded	120 patients with cervical radiculopathy (disc herniation or spinal stenosis)	Ultrasound–guided vs fluoroscopy-guided	Significant improvements in pain reduction for all subjects ($p < 0.05$) in both Fluoroscopy and Ultrasound groups. Intravascular injections: 0-US - 5-FL ($p > 0.05$)	Fluoroscopy-guided transforaminal block and Ultrasound-guided nerve root block provide similar pain relief.	Moderate
Rathmell et al., 2015 Safeguards to prevent neurologic complications after epidural steroid injections consensus opinions from a multidisciplinary working group and national organizations	Consensus Opinions from Multi-Disciplinary Working Group and National Organizations	Collaboration between the FDA, expert multi-disciplinary working group and 13 professional societies	N/A	17 guidelines created Recommendations #3, #4, #8, #9: All cervical IL ESIs should be performed using image guidance, with appropriate AP, lateral, or contralateral oblique views and a test dose of contrast medium Cervical TF ESIs should be performed by injecting contrast medium under real-time fluoroscopy and/or digital subtraction imaging, using an AP view, before injecting any substance that may be hazardous to the patient Cervical IL ESI are recommended to be performed C7 to T1 but preferably not higher than the C6 – C7 level Pre-procedure imaging review of the cervical epidural space. Cervical IL ESI should not be taken without reviewing “prior imaging studies that show there is adequate epidural space for needle placement at the target level”	Imaging guidance (fluoroscopic) should be used for all epidural spinal injections	Low

Obernauer et al., 2013 Ultrasound-guided versus Computed Tomography-controlled facet joint injections in the middle and lower cervical spine: a prospective randomized clinical trial	Prospective randomized clinical trial	40 patients	US-guided cervical intra-articular facet joint injections compared to CT-guided intra-articular facet joint injections	US-guided injections: Accuracy 100%, mean time (min:sec) to final needle placement 04:46 in one level injections and 05:49 in two level injections. Total radiation dose (including CT confirmation for study purposes in the US group) was 27.6 mGy*cm for one level and 32.5 mGy*cm for two level. CT-guided injections: Accuracy 95%, mean time (min:sec) to final needle placement 11:12 one level, 14:32 two level. Total radiation dose was 88.2 mGy*cm for one level and 205.0 mGy*cm for two level.	US-guided therapeutic cervical intraarticular facet injections are accurate, feasible, and carry reduced risk of complications when compared to CT-guided injections. The radiation dose, procedure time and level of required resources is significantly less for the Ultrasound-guided procedure.	Moderate
Initial QOE Score Across Studies for PICO #6: **Low (3)**						

SEMPI Grading QOE – Table 1B.6b – Risk of Bias		
PICO #6: In adults with non-traumatic radicular neck pain, which imaging modality is preferred to facilitate interventional pain management procedures?		
Evaluate Outcome for Risk of Bias Across Studies		
Initial QOE Score Across Studies for PICO: **LOW**		
Criteria	**Assessment**	**Reason for Assessment**
Negative Bias		
Risk of Bias	Serious	Limited studies with comparative analysis. Limited multi-modality comparison. Randomization ill defined, unblinded, single center-single proceduralist studies
Inconsistency	Not serious	
Indirectness	Serious	Imaging modalities availability and expertise limits the applicability
Imprecision	Not Serious	
Positive Bias		
Strength of Association	Low	
Other Considerations	No	
Overall Effect of Bias on Initial QOE Grade: Downgraded to Very low		
Final QOE Grade for Outcome Across Studies: **LOW**		
High – Very confident the true effect lies close to that of the estimate of the effect **Moderate** – Moderately confident in the effect estimate (the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different) **Low** – Confidence in the effect estimate is limited (the true effect may be substantially different from the estimate of effect) **Very Low** – Very little confidence in the effect estimate (the true effect is likely to be substantially different from the estimate of effect)		

SEMPI Grading QOE – Table 1B.6c – Evidence to Recommendations				
PICO #6: In adults with non-traumatic radicular neck pain, which imaging modality is preferred to facilitate interventional pain management procedures?				
SEMPI Quality of Evidence (QOE) & Recommendation Strength				
Author/Year/Title	Highlights	SEMPI QOE Rating	Final QOE Category	Recommendation Strength
Amrhein et al., 2017 Incidence of Inadvertent Dural Puncture During CT Fluoroscopy-Guided Interlaminar Epidural Corticosteroid Injections in the Cervical Spine: An Analysis of 974 Cases	Inadvertent dural puncture rate is similar to previously reported rates for conventional fluoroscopy (limited to the lower cervical spine only) CT fluoroscopy– guided cervical interlaminar epidural injections can be performed at all levels throughout the cervical spine	Low	Very Low (4)	Consensus (B)
Park et al., 2017 Ultrasound versus fluoroscopy-guided cervical medial branch block for the treatment of chronic cervical facet joint pain: a retrospective comparative study.	US guided CMBB requires shorter administration duration and fewer needle passes.	Low		
Jee et al., 2013 Ultrasound-guided selective nerve root block versus fluoroscopy-guided transforaminal block for the treatment of radicular pain in the lower cervical spine: a randomized, blinded, controlled study	FL-guided transforaminal block and US-guided nerve root block provided similar pain relief. Less intravascular uptake with US.	Moderate		
Rathmell et al., 2015 Safeguards to prevent neurologic complications after epidural steroid injections consensus opinions from a multidisciplinary working group and national organizations	Imaging guidance (fluoroscopic) should be used for all epidural spinal injections	Low		
Obernauer et al., 2013 Ultrasound-guided versus Computed Tomography-controlled facet joint injections in the middle and lower cervical spine: a prospective randomized clinical trial	US-guided therapeutic cervical intra-articular facet injections are accurate, feasible, and carry reduced risk of complications when compared to CT-guided injections. There is no significant difference in pain reduction between the two procedures. The radiation dose, procedure time and level of required resources is significantly reduced for the US-guided procedure.	Moderate		

Recommendation Rating: 4B—Consensus recommendation for the intervention based on very low-quality evidence
Justification: Lack of consistency in finding across studies and unidentified "best approach" for needle guidance results in consensus recommendation and downgrading due to significant bias.

Rating Definitions:

Quality of Evidence: High quality = **1**; Moderate quality = **2**; Low quality = **3**; Very low quality = **4**
Strength of Recommendation: A = Strength of Recommendation from Consistent Evidence; **B** = Strength of Recommendation from Panel Consensus

Conclusion: Current practice management guidelines recommend the use of image-guidance for epidural steroid injections (ESI) as they reduce the risk of associated complications and provide better outcomes (Rathmell et al., 2015). Epidural steroid injections are indicated in interventional pain management for cervical radicular pain and can be performed through interlaminar or transforaminal approaches (Kim, 2018). Current evidence is mixed regarding which approach and which imaging technique (ultrasound, fluoroscopy, CT) demonstrates the highest safety and efficacy (Engel et al., 2014; Wei, 2016). Fluoroscopy has long been used for imaging guidance in spinal pain management for cervical interlaminar ESIs; for cervical transforaminal ESIs and cervical intra articular facet injections it is debatable if these should be done at all, and if they should be done, it remains questionable whether fluoroscopy, CT or ultrasound should be used. Computed tomography (CT) has also been used, alone or in conjunction with fluoroscopy (Amrhein et al., 2017; Wald et al., 2014; Hassan & Sherman, 2019). Recent studies also support ultrasound guidance for some cervical spine procedures, with similar efficacy to that of CT or fluoroscopy (Wald et al., 2014), while posing no radiation risk. Patient obesity and operator-dependence, however, limit more widespread use of ultrasound.

Final Recommendation: **4B**— In adults with non-traumatic neck pain, who warrant interventional pain management:

- Fluoroscopic or CT guidance is recommended for cervical interlaminar epidural steroid injections and medial branch radiofrequency ablations
- Fluoroscopic, ultrasound or CT imaging guidance is recommended for needle placement for cervical medial branch blocks, cervical transforaminal epidural steroid injections/selective nerve root blocks, and cervical intra-articular facet joint injections

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