RAYUS QUALITY INSTITUTE

PROVIDER LED ENTITY

Cervical Spine/Neck Pain AUC

2022 Update

Appropriateness of advanced imaging procedures* in patients with cervical spine/neck pain and the following clinical presentations

*Including MRI, CT, CT myelography, bone scan, PET, PET/CT, SPECT, SPECT/CT

Abbreviation list:

ACOEM	American College of Occupational and Environmental Medicine
ACP	American College of Physicians
ACR	American College of Radiology
APS	American Pain Society
ASNR	American Society of Neuroradiology
AUC	Appropriate Use Criteria
CES	Cauda equina syndrome
CMS	Centers for Medicare & Medicaid Services
CRP	C-reactive protein
CT	Computed tomography
DISH	Diffuse idiopathic skeletal hyperostosis
EMTALA	Emergency Medical Treatment and Labor Act
ESR	Erythrocyte sedimentation rate
FDG	Fluorodeoxyglucose
ICSI	Institute for Clinical Systems Improvement
IDSA	Infectious Diseases Society of America
MRI	Magnetic resonance imaging
NASS	North American Spine Society
NCCN	National Comprehensive Cancer Network
NCD	National Coverage Determination
OPLL	Ossification of posterior longitudinal ligament
PET	Positron emission tomography
PLE	Provider Led Entity
SCBTMR	Society of Computed Body Tomography & Magnetic Resonance
SPECT	Single-photon emission computed tomography
SSR	Society for Skeletal Radiology
STIR	Short tau inversion recovery sequence
VA/DoD	Veterans Affairs/Department of Defense
WBC	White blood cell

Appropriate Use Criteria: How to Use this Document

The RAYUS Radiology Quality Institute follows the recommendation framework defined by the Appraisal of Guidelines for Research & Evaluation (AGREE II), AMSTAR 2 (A Measurement Tool to Assess Systematic Reviews) and a modified version of the QUADAS-2 (Quality Assessment of Diagnostic Accuracy Studies) to evaluate the strength of recommendations concerning advanced imaging. Considerations used to determine a recommendation are listed below.

Primary recommendation (green): A strong recommendation for imaging; there is confidence that the desirable effects of imaging outweigh its undesirable effects.

Alternative recommendation (yellow): A conditional recommendation for imaging; the desirable effects of imaging likely outweigh its undesirable effects, although some uncertainty may exist. The individual patient's circumstances, preferences, and values should be considered on a case-by-case basis. This may include: contraindication to the primary recommendation, specific clinical circumstances that require use of the alternative recommendation, or the primary recommendation has results that are inconclusive or incongruent with the patient's clinical diagnosis. Case-by-case indications to consider have been noted in brackets.

Recommendation against imaging (red): The undesirable effects of imaging outweigh any desirable effects. Additionally, the recommendation may be impractical or not feasible in the targeted population and/or practice setting(s).

Neck pain AUC summary:

- Advanced imaging is not routinely recommended for patients with uncomplicated neck pain, an absence of red flags, and no trial of conservative management (generally for ≥ 4 weeks).
- Urgent or emergent advanced imaging is indicated for neck pain patients with red flags, such as suspicion of cancer, infection, fracture, or major/progressive neurological deficits.
- Advanced imaging is typically recommended in patients with moderate or severe pain if the pain is uncontrolled, increasing in severity, with moderate or marked dysfunction, with moderate or progressive neurologic deficits, or when conservative therapy has failed.
- Many guidelines recommend **MRI** the preferred imaging modality for neck pain. MRI does not use ionizing radiation and provides better visualization of neurologic structures, soft tissue pathology, and the spinal canal. It is also more sensitive for marrow abnormalities such as neoplasm and fracture. The addition of contrast may be useful for cases of suspected cancer or infection, unexplained neurologic disorders, previous history of cervical spine surgery, or further evaluation of abnormalities noted on previous noncontrast imaging.
- **CT** is indicated for patients unable to undergo MRI, with equivocal findings on MRI, with discordant MRI findings and clinical symptoms, for surgical planning or fusion evaluation, and to characterize bone lesions.
- **CT myelography** may be useful in patients who cannot undergo MRI to evaluate neurologic deficits or suspected intradural pathology. It may also be needed in patients with myelopathy, radiculopathy, or stenosis if metal artifact arising from instrumentation limits adequate visualization of neurologic structures on MRI.
- **Bone scan** with **SPECT** or **SPECT/CT** is indicated to evaluate for metastatic disease in patients with indeterminate bone lesions previously detected on MRI or CT. It can also be useful in patients who cannot undergo MRI to evaluate infection, to evaluate bone lesions and to detect or evaluate the chronicity of fractures.
- The indications for **PET or PET/CT** in the evaluation of neck pain are limited, however these modalities can be used to evaluate indeterminate bone lesions in patients with known PET-sensitive cancer.
- High velocity or other major trauma likely meets the *EMTALA* definition of a suspected or confirmed emergency medical condition. In these instances, it would be excluded from these imaging recommendations.

Neck pain and/or radiculopathy with no red flags or complicating features; patient has not completed an appropriate period (≥ 4 weeks) of conservative therapy:

- **Red – MRI**
- **Red - CT or CT myelography**
- **Red – Bone scan, SPECT, SPECT/CT**
- **Red – PET or PET/CT**
- **Red – Gallium scan whole body**
- **Red – WBC scan**

Level of Evidence: Low

Notes concerning applicability and/or patient preferences: none

Guideline and PLE expert panel consensus opinion summary:
Overview:
Many high-quality guidelines agree that clinicians should not routinely recommend imaging for patients with uncomplicated neck pain, an absence of red flags, and no prior management (Bussieres et al 2008; Guzman et al 2009; Hegmann et al [*ACOEM*] 2016; McDonald et al [*ACR*] 2018). Many cases of acute cervical or neck pain resolve, and therefore MRI or CT are not considered first-line imaging modalities in the setting of acute uncomplicated neck pain (McDonald et al [*ACR*] 2019).

In adult patients with cervical pain and no improvement or worsening of symptoms following 4 or more weeks of conservative therapy, imaging may be indicated. Immediate imaging may also be indicated if the patient has uncontrolled pain, if pain prevents the patient from performing activities of daily living, or if the patient develops major or progressive neurologic abnormalities (McDonald et al [*ACR*] 2019; Bussières et al 2008; Hegmann et al [*ACOEM*] 2016; PLE expert panel consensus opinion).

Clinical notes:
- Most patients with neck pain will improve following noninvasive conservative therapy (PLE expert panel consensus opinion).
- The routine use of radiographs is not recommended for acute, non-specific cervicothoracic pain (Hegmann et al [*ACOEM*] 2016). In the absence of red flag symptoms, therapy is rarely altered by radiographic findings (McDonald et al [*ACR*] 2019).

Evidence update (2018-present):
There were no recent articles that significantly affected the recommendations or conclusions found in the guidelines referenced above.

Neck pain (without radiculopathy) and either of the following:

- **Failure of conservative therapy***
- **Planning or evaluation for injection therapy or surgery**

  - **Green** – **MRI cervical spine without IV contrast** or **MRI cervical spine without and with IV contrast**
  - **Yellow** – **MRI cervical spine with IV contrast**
    [further evaluate abnormalities previously noted on noncontrast imaging]
  - **Yellow** – **CT cervical spine without IV contrast** or **CT myelography cervical spine**
    [*MRI contraindicated or findings indeterminate; intervention planning; further evaluate/characterize bone lesion(s)*]
  - **Yellow** – **Bone scan**, **SPECT, SPECT/CT**
    [*further evaluate or characterize bone lesion(s)*]
  - **Red - PET** or **PET/CT; Gallium scan whole body; WBC scan**; **CT with IV contrast; CT without and with IV contrast**

*Failure of conservative care can be defined as moderate to severe persistent symptoms following conservative care for 4 weeks, increasing pain during a trial of conservative care, uncontrolled pain, significant limitation of function, inability to perform the activities of daily living, or inability to participate in noninvasive care for an appropriate period of time (PLE expert panel consensus opinion).

Level of Evidence: Moderate

Notes concerning use of contrast:
MRI IV contrast is often indicated for cases of suspected cancer or infection, in patients with unexplained neurologic deficits, in patients with a history of prior surgery, or to evaluate abnormalities noted on prior noncontrast imaging.

Notes concerning applicability and/or patient preferences: none

Guideline and PLE expert panel consensus opinion summary:
Overview:
Advanced imaging, preferably with MRI, is recommended for neck pain that progresses despite a trial of adequate conservative therapy (Bono et al [*NASS*] 2011; McDonald et al [*ACR*] 2019; Guzman et al 2009; Bussieres et al 2008; Hegmann et al [*ACOEM*] 2016; PLE expert panel consensus opinion). Imaging is also appropriate when there is severe impairment not trending towards improvement and injection is being considered, or the patient is a candidate for early surgical treatment (Hegmann et al [*ACOEM*] 2016). CT is indicated in patients who cannot undergo MRI, to evaluate or define indeterminate findings on MRI, or for surgical planning (PLE expert panel consensus opinion). CT myelography may be indicated in patients who cannot undergo MRI to evaluate for suspected or known intradural abnormalities, to evaluate for significant or critical central canal stenosis, or to evaluate findings which are indeterminate on CT (PLE expert panel consensus opinion). Its use may also be considered in patients with metal artifact arising from implants or instrumentation, or for surgical planning (PLE expert panel consensus opinion). Myelography is invasive, however, with some risk of injection and post-myelography headache (PLE expert panel consensus opinion). Bone scintigraphy and SPECT can on occasion be useful to

evaluate for the source of neck pain, such as follow-up evaluation of a bone lesion (PLE expert panel consensus opinion).

Clinical notes:

- Practitioners should emphasize that acute neck pain is nearly always benign and generally resolves within 1 to 6 weeks, and that the first line of treatment for neck pain is conservative care (PLE expert panel consensus opinion).
- Conservative care may consist of spinal manipulative therapy, exercise therapy, physical therapy, cognitive behavioral therapy, multidisciplinary rehabilitation, pharmacologic therapy, or time (for patients unable or unwilling to undergo available noninvasive treatments) (PLE expert panel consensus opinion).

Technical notes:

- Findings on MRI and CT are nonspecific and require strict correlation of symptoms and findings on physical exam to determine the significance (PLE expert panel consensus opinion).

Evidence update (2018-present):

There were no recent articles that significantly affected the recommendations or conclusions found in the guidelines referenced above.

Cervical radiculopathy and any of the following:

- **Failure of conservative therapy***
- **Major or progressive neurologic deficits**
- **Planning or evaluation for injection therapy or surgery:**

  - **Green** – **MRI cervical spine without IV contrast** or **MRI cervical spine without and with IV contrast**
  - **Yellow** – **MRI cervical spine with IV contrast**
    [further evaluate abnormalities previously noted on noncontrast imaging]
  - **Yellow** – **CT cervical spine without IV contrast** or **CT myelography cervical spine**
    [*MRI contraindicated or findings indeterminate; intervention planning*]
  - **Red** – **Bone scan; SPECT; SPECT/CT; PET** or **PET/CT; Gallium scan whole body; WBC scan; CT with IV contrast; CT without and with IV contrast**

*Failure of conservative care can be defined as moderate to severe persistent symptoms following conservative care for 4 weeks, increasing pain during a trial of conservative care, uncontrolled pain, significant limitation of function, inability to perform the activities of daily living, or inability to participate in noninvasive care for an appropriate period of time (PLE expert panel consensus opinion).

Level of Evidence: Moderate

Notes concerning use of contrast:
The use of MRI IV contrast may be indicated in patients with radiculopathy if they have unexplained neurologic deficits, a suspected or possible neurologic disorder, or if they have a history of prior surgery. Follow-up imaging with contrast may also be indicated for further evaluation of abnormalities previously seen on noncontrast imaging.

Notes concerning applicability and/or patient preferences: none

Guideline and PLE expert panel consensus opinion summary:
Overview:
Advanced imaging is recommended for neck pain and upper extremity radiculopathy that progresses despite a trial of adequate conservative therapy (Bono et al [*NASS*] 2011; McDonald et al [*ACR*] 2019; Guzman et al 2009; Bussieres et al 2008; Hegmann et al [*ACOEM*] 2016; PLE expert panel consensus opinion). It is also recommended for radiculopathy patients who are candidates for interventional or surgical treatment (Bono et al [*NASS*] 2011: grade B recommendation; Guzman et al 2009).

MRI cervical spine:
MRI is the procedure of choice for the evaluation of cervical radiculopathy as it does not use ionizing radiation and is superior for direct visualization of neurologic structures, surrounding soft tissue pathology, and vertebral marrow (Bussieres et al 2008; Hegmann et al [*ACOEM*] 2016: level C recommendation, high level of confidence; Bono et al [*NASS*] 2011: grade B recommendation; McDonald et al [*ACR*] 2019). MRI may be considered if there is severe impairment not trending towards improvement and injection is being considered, or patient is a candidate for early surgical treatment if supportive MRI findings are found (Hegmann et al [*ACOEM*] 2016). Preoperative MRI can also be used to

confirm a compressive lesion in the setting of cervical radiculopathy prior to elective spine surgery (Mummaneni et al 2009: Class II evidence, strength C recommendation; Hegmann et al [*ACOEM*] 2016). MRI can assess cord abutment/signal changes secondary to spinal canal narrowing, or to evaluate exiting nerve roots in the setting of radiculopathy (McDonald et al [*ACR*] 2019).

CT cervical spine:
If there is a contraindication to MRI, CT may be considered as the initial study to confirm correlative compressive lesions in cervical spine patients who have failed a course of conservative therapy and who may be candidates for interventional or surgical treatment (Bono et al [*NASS*] 2011; work group consensus statement; PLE expert panel consensus opinion). CT provides good definition of bony elements and is helpful in the assessment of neuroforaminal stenosis (McDonald et al [*ACR*] 2019; PLE expert panel consensus opinion). However, CT is less sensitive than MRI for evaluating nerve root compression (McDonald et al [*ACR*] 2019).

CT myelography cervical spine:
MRI has mostly supplanted CT myelography as a first-line modality for complex cervical radiculopathy; however, myelography can be considered in patients with contraindication to MRI, or in those with equivocal MRI findings (McDonald et al [*ACR*] 2019; Bono et al [*NASS*] 2011: grade B recommendation). It is also useful to confirm correlative compressive lesions in patients who have failed a course of conservative therapy and who may be candidates for interventional or surgical treatment (Mummaneni et al 2009: Class II evidence, strength C recommendation; PLE expert panel consensus opinion). CT myelography can be useful to help identify cord compression related to cervical spinal stenosis from ossification of posterior longitudinal ligament (OPLL) (McDonald et al [*ACR*] 2019; PLE expert panel consensus opinion).

<u>Clinical notes:</u>

- Early treatment of neck pain and/or radiculopathy is noninvasive and may consist of spinal manipulative therapy, exercise therapy, physical therapy, use of external stimulators and/or pharmacologic treatment (PLE expert panel consensus opinion).
- Failure of conservative care can be defined as moderate to severe persistent symptoms following an appropriate period of conservative care (typically 4 weeks), increasing pain during conservative care, uncontrolled pain, marked limitation of function, inability to perform the activities of daily living or inability to participate in conservative care for an appropriate period of time (PLE expert panel consensus opinion).

<u>Technical notes:</u>

- Findings on MRI and CT are nonspecific and require strict correlation of symptoms and findings on physical exam to determine the significance (PLE expert panel consensus opinion).

<u>Evidence update (2018-present):</u>
There were no recent articles that significantly affected the recommendations or conclusions found in the guidelines referenced above.

Neck pain and/or radiculopathy with suspicion of cancer:

- Green – **MRI cervical spine without IV contrast** or **MRI cervical spine without and with IV contrast**
- Yellow – **MRI cervical spine with IV contrast**
  [further evaluate abnormalities previously noted on noncontrast imaging]
- Yellow – **CT cervical spine without IV contrast** or **CT myelography cervical spine**
  [*MRI contraindicated; MRI findings indeterminate; intervention planning; further evaluate or characterize bone lesion(s)*]
- Yellow – **Bone scan**, **SPECT**, **SPECT/CT**
  [*further evaluate or characterize bone lesion(s)*]
- Yellow – **PET** or **PET/CT**
  [*further evaluate or characterize bone lesion(s)*]
- Red – **Gallium scan whole body; WBC scan; CT without and with IV contrast; CT with IV contrast**

Level of Evidence: Moderate

Notes concerning use of contrast:
MRI IV contrast may be indicated for cases of suspected or known cancer, particularly to evaluate unexplained neurologic deficits, to evaluate for intradural or paraspinal metastases, or to characterize intramedullary/intradural lesions. Follow-up imaging with contrast may also be indicated for further evaluation of abnormalities previously seen on noncontrast imaging.

Notes concerning applicability and/or patient preferences: none

Guideline and PLE expert panel consensus opinion summary:
Overview:
Neck pain with suspicion of cancer is a red flag and urgent diagnostic imaging is recommended (Nabors et al [*NCCN*] 2022; Hegmann et al [*ACOEM*] 2016). In patients with new onset pain, cancer may be suspected in patients with a previous history of cancer, clinical signs such as unexplained weight loss, abnormalities on plain radiographs, or unexplained laboratory abnormalities (e.g., elevated ESR) (Hegmann et al [*ACOEM*] 2016; PLE expert panel consensus opinion). MRI is generally preferred as the initial advanced imaging modality in this scenario (Chou et al [*ACP & APS*] 2007; Nabors et al [*NCCN*] 2022; PLE expert panel consensus opinion).

MRI cervical spine:
MRI is preferred for neck pain with cancer-related concerns, as it does not use ionizing radiation and provides better visualization of soft tissue, the vertebral marrow, and the spinal canal (McDonald et al [*ACR*] 2019; Hegmann et al [*ACOEM*] 2016: strength C evidence, high level of confidence; Bussieres et al 2008; Nabors et al [*NCCN*] 2022). Its use is indicated for the evaluation of patients with new onset pain and a history of cancer, or those with indeterminate or aggressive lesions on plain radiographs with or without a history of cancer (PLE expert panel consensus opinion; Bestic et al [*ACR*] 2020). The use of MRI without and with contrast is considered the gold standard of imaging central nervous system cancers (Nabors et al [*NCCN*] 2022). The use of IV contrast with MRI improves the sensitivity and specificity for intradural lesions and can be helpful in patients with a clinical suspicion for intradural metastases,

intradural/perineural neoplasm, and/or cord abnormalities noted on previous noncontrast MRI (PLE expert panel consensus opinion).

CT cervical spine:
The sensitivity of CT is relatively low in early malignant bone involvement, making MRI the favored initial diagnostic modality (McDonald et al [*ACR*] 2019). However, CT is indicated in those who cannot undergo MRI with new onset neck pain and a history of cancer, abnormalities on conventional radiographs, or clinical suspicion of cancer (McDonald et al [*ACR*] 2019; PLE expert panel consensus opinion; Nabors et al [*NCCN*] 2022). CT can also be a helpful tool in the detection and characterization of bony abnormalities, such as occult bone tumors and destructive osseous lesions (Bestic et al [*ACR*] 2020; Bussieres et al 2008).

CT myelography cervical spine:
CT myelography is indicated to evaluate for intradural neoplasm or spinal metastases in patients with new or progressive neurologic symptoms who cannot undergo MRI, in patients with indeterminate findings on MRI, and in patients with substantial metal artifact arising from implants and/or instrumentation (Nabors et al [*NCCN*] 2022; PLE expert panel consensus opinion). Myelography is invasive with some risk of injection and post-myelography headache (PLE expert panel consensus opinion).

Bone scan, SPECT, SPECT/CT:
While not typically used as an initial imaging study, bone scan, often accompanied by SPECT or SPECT/CT, may be useful for further characterization or evaluation of suspicious or indeterminate lesions detected on MRI or CT, or to evaluate for multiple bone lesions in patients with metastatic disease (McDonald et al [*ACR*] 2019; Bestic et al [*ACR*] 2020; PLE expert panel consensus opinion). It also remains a viable imaging option in select cases in which MRI is not clinically feasible (Bestic et al [*ACR*] 2020. For marrow-based lesions, radionuclide scanning has a sensitivity of 0.75-0.98 (Bussieres et al 2008).

PET or PET/CT:
While not commonly used as a first-line imaging modality, FDG-PET can be a valuable adjunct to conventional imaging in the diagnosis of primary bone tumors (Bestic et al [*ACR*] 2020; McDonald et al [*ACR*] 2019), particularly in patients with known PET-sensitive cancers (PLE expert panel consensus opinion).

<u>Clinical notes:</u>

- Neoplastic abnormalities of the spine in adult patients may include intramedullary masses, intradural extramedullary masses, intradural leptomeningeal disease, bone tumors, extradural soft-tissue neoplasms, soft-tissue masses, and tumors of nerves, muscle, or connective tissue (*ACR–ASNR–SCBT-MR–SSR* 2018).
- There is no consensus available on the most predictive clinical signs of vertebral malignancy in the cervical spine. Our recommendations are based on the lumbar spine literature, however, the incidence of malignancy in the cervical spine may not be as high as it is in the lumbar spine (PLE expert panel consensus opinion).
- In the lumbar spine literature, a history of cancer was found to be the only factor with a significant likelihood ratio for malignancy (Chou et al [*ACP*] 2011). Unexplained weight loss, lack of improvement after 1 month and age older than 50 years of age were weaker predictors (Chou

et al [*ACP*] 2011). Lymphadenopathy and an elevated ESR might also prompt additional evaluation (PLE expert panel consensus opinion).
- In patients with new onset neck pain and secondary flags for malignancy, imaging might reasonably be deferred unless symptoms do not improve over several weeks as is recommended in the lumbar spine (Chou et al [*ACP*] 2011). Another strategy would be to obtain radiographs and an ESR and to reserve immediate MRI or CT to patients with abnormalities on one of these tests (Chou et al [*ACP & APS*] 2007).

Technical Notes:
- STIR, T2 fat saturation and/or diffusion-weight images may increase the conspicuity and sensitivity for vertebral neoplasm (PLE expert panel consensus opinion).

Evidence update (2018-present):
Low Level of Evidence:
Won et al (2022) retrospectively assessed the validity of MRI in predicting the pathology and location of spinal cord tumors in routine clinical settings. A total of 820 patients with primary spinal cord tumors and pathological confirmation were included. Sensitivity, specificity, and positive/negative predictabilities were evaluated for tumor location (456 intradural extramedullary; 165 intramedullary, and 156 extradural) and pathology. The overall sensitivity and specificity were over 90.0%. However, the sensitivity became lower when the tumor resided simultaneously in two spaces such as in the intradural-and-extradural or intramedullary-and-extramedullary space (54.6% and 30.0%, respectively). The most common pathology was schwannoma (n = 416), followed by meningioma (114) and ependymoma (87). Sensitivities were 93.3%, 90.4%, and 89.7%, respectively. Specificities were 70.8%, 82.9%, and 76.0%. In rare tumors such as neurofibromas, and diffuse midline gliomas, the sensitivity was much lower (less than 30%). The authors conclude that, for common locations and pathologies, the validity of MRI is generally satisfactory. However, for rare locations and pathologies, MRI diagnosis still needs some improvement.

Liu et al (2020) analyzed CT, MR, and [FDG PET] emission computed tomography ([ECT]) in diagnosing [bone] spinal tumors of 121 patients. Each patient underwent $\geq$ 2 imaging exams, with all diagnosed by pathology after core needle or surgical biopsy. The kappa coefficient of MR, CT, and [FDG PET] ECT was 46.1%, 36.0%, and 55.9%, respectively. The area under the curve of [FDG PET] ECT, MR, and CT scans was 0.809, 0.705, and 0.704, respectively; and the differences among them were significant ($P < .05$). Post hoc multiple comparisons showed no significant differences among imaging examinations in terms of sensitivity, specificity, misdiagnosis rate, and coincidence rate ($P > .05$). Although [FDG PET] ECT was the most accurate imaging method, its large radiation dosage limits its widespread application. Furthermore, MR verified spinal tumors more effectively; however, CT excluded them more efficiently. In summary, when all factors are considered, MR is still the optimal modality for the diagnosis of [bone] spinal tumors, especially during the initial screening.

Neck pain and/or radiculopathy with suspicion of infection:

- Green – **MRI cervical spine without IV contrast** or **MRI cervical spine without and with IV contrast**
- Yellow – **MRI cervical spine with IV contrast**
  [further evaluate abnormalities previously noted on noncontrast imaging]
- Yellow – **CT cervical spine without and/or with IV contrast** or **CT myelography cervical spine**
  [*MRI contraindicated or findings indeterminate; intervention planning*]
- Yellow – **Bone scan, SPECT, SPECT/CT**
  [MRI contraindicated or findings indeterminate]
- Yellow **– Gallium scan whole body** [with or without **SPECT** or **SPECT/CT**]
  [MRI contraindicated or findings indeterminate]
- Red – **WBC scan**; **PET** or **PET/CT**

Level of Evidence: Moderate

Notes concerning use of contrast:
MRI IV contrast is often indicated for cases of suspected infection. It can be useful to characterize disc, epidural, paraspinous, or osseous abnormalities noted on noncontrast MRI and is useful to differentiate phlegmon from abscess.

Notes concerning applicability and/or patient preferences: none.

Guideline and PLE expert panel consensus opinion summary:
Overview:
Neck pain with suspected infection is a red flag and urgent diagnostic imaging is advised (PLE expert panel consensus opinion; Hegmann et al [*ACOEM*] 2016). There is agreement among multiple high-quality guidelines (Bussieres et al 2008; Chou et al [*ACP & APS*] 2007; *VA/DoD* 2017; Berbari et al [*IDSA*] 2015; Ortiz et al [*ACR*] 2021; McDonald et al [*ACR*] 2019) that imaging, preferably with MRI, is indicated when spine infection is suspected.

MRI cervical spine:
MRI is preferred for neck pain and infection-related concerns, including new pain following an invasive spine procedure (Bussieres et al 2008; Hegmann et al [*ACOEM*] 2016: strength C evidence, high level of confidence; Ortiz et al [*ACR*] 2021; McDonald et al [*ACR*] 2019; PLE expert panel consensus opinion). Compared to CT, it does not use ionizing radiation and provides better visualization of soft tissue, the vertebral marrow, and the spinal canal (Chou et al [*ACP & APS*] 2007). MRI has high sensitivity and specificity, and allows for the diagnosis of infection prior to the appearance of bone destruction on CT or conventional radiographs (Berbari et al [*IDSA*] 2015). MRI has been shown to be more accurate than radiography and bone scan (sensitivity of 96%, specificity of 92%, accuracy of 94%) for suspected osteomyelitis, spondylodiscitis, septic disc, paraspinous abscess, and epidural abscess (Bussières et al 2008; Berbari et al [*IDSA*] 2015; McDonald et al [*ACR*] 2019). MRI without and with IV contrast is often utilized, due to excellent tissue characterization and anatomic delineation (Ortiz et al [*ACR*] 2021). MRI without IV contrast can show findings suggestive of possible spine infection, including marrow or paraspinal muscle edema, abnormal fluid collections, areas of abnormal signal, and abnormality within the intervertebral disc (Ortiz et al [*ACR*] 2021). MRI with IV contrast can be useful for additional

information in a patient who has had a recent corresponding MRI without IV contrast, and is also useful to differentiate phlegmon from abscess (Patel et al 2014; PLE expert panel consensus opinion).

CT cervical spine:
CT is indicated in patients with neck pain and a suspicion of infection who cannot undergo MRI (Berbari et al [*IDSA*] 2015: weak recommendation, low quality evidence). CT may also be useful to evaluate for poorly demarcated endplate erosions or endplate destruction in patients with findings on MRI which are indeterminate for infection, to evaluate for endplate destruction in patients with abnormalities on plain radiographs, or to evaluate patients for surgical planning (Ortiz et al [*ACR*] 2021; PLE expert panel consensus opinion; Bussieres et al 2008). It can also identify the presence of gas within an abscess or lack of gas within the disc space (McDonald et al [*ACR*] 2019).

CT myelography cervical spine:
CT myelography is indicated to evaluate for osteomyelitis or spondylodiscitis in patients who cannot undergo MRI or who have substantial metal artifact arising from implants and/or instrumentation (PLE expert panel consensus opinion). CT myelography may also be needed for surgical planning (PLE expert panel consensus opinion). Myelography is invasive however, with some risk of infection and post-myelography headache (PLE expert panel consensus opinion).

3-Phase Bone Scan
With a high sensitivity but low specificity, 3-phase bone scan can be utilized in select situations for suspected spine infection (Ortiz et al [*ACR*] 2021).

Gallium Scan whole body [with or without **SPECT** or **SPECT/CT**]
Ga-67 scintigraphy combined with SPECT (or combination spine gallium/Tc99 bone scan) can be useful when MRI cannot be obtained (Ortiz et al [*ACR*] 2021; Berbari et al [*IDSA*] 2015: weak recommendation, low quality evidence). Gallium scan is less sensitive but more specific than skeletal scintigraphy to evaluate for suspected spine infection (Ortiz et al [*ACR*] 2021). Higher sensitivity and resolution can be achieved with SPECT/CT (McDonald et al [*ACR*] 2019).

WBC Scan
Indium-tagged WBC scanning lacks sensitivity in the diagnosis of native vertebral osteomyelitis and should not be primarily used in establishing the diagnosis (Berbari et al [*IDSA*] 2015; McDonald et al [*ACR*] 2019).

PET or PET/CT
Recent guidelines note that PET may be considered as a complementary imaging modality in select patients with suspected infection (Ortiz et al [*ACR*] 2021; Berbari et al [*IDSA*] 2015: weak recommendation, low level of evidence). However, a CMS national non-coverage determination for use of FDG PET among patients with infection exists (*NCD 220.6.16*). CMS has determined that the evidence is inadequate to conclude that FDG PET improves health outcomes in the Medicare population.

<u>Clinical notes:</u>

- Infectious conditions may include spinal infection, such as disc space infection, vertebral osteomyelitis, epidural abscess, and surrounding soft-tissue infection, including postoperative infections. It may also include spinal cord infection, including abscess (*ACR–ASNR–SCBT-MR–SSR* 2018).

- Clinical features predicting the presence of vertebral infection may include new or worsening back pain with a fever (Thorson et al [*ICSI*] 2018; Berbari et al [*IDSA*] 2015), new or worsening back pain and elevated ESR or CRP (Berbari et al [*IDSA*] 2015), new moderate or severe pain following an invasive spine procedure (Chou et al [*ACP* & *APS*] 2007), new onset pain in a high-risk patient, and disproportionate pain (PLE expert panel consensus opinion).
- Risk factors for infection include recent infection, IV drug use, diabetes, immunosuppression, liver or renal failure, and recent spine procedures or surgery (McDonald et al [*ACR*] 2019; PLE expert panel consensus opinion).
- While imaging has a role in the diagnostic evaluation of suspected spine infection, a high index of clinical suspicion for an infectious etiology is required, and laboratory parameters should include serum ESR, CRP, WBC count with differential, and blood cultures (Ortiz et al [*ACR*] 2021).
- In patients with new onset neck pain and no fever, plain radiographs and a CRP or ESR may prove useful to triage patients. Advanced imaging can be obtained if either of these tests are abnormal (McDonald et al [*ACR*] 2019). An elevated ESR or CRP result in patients with back pain, though not specific, has a sensitivity that can range from 94% to 100% (Berbari et al [*IDSA*] 2015).

Technical notes:

- STIR or T2 fat saturation images are useful to identify marrow edema and paraspinous/epidural edema, phlegmon or abscess (PLE expert panel consensus opinion).
- Diffusion-weight imaging (the “claw sign”) may help differentiate inflammatory disc degeneration from vertebral spondylodiscitis (Patel et al 2014).

Evidence update (2018-present):

Shroyer et al (2022) conducted a single-center prospective cohort study to describe pyogenic spinal infection imaging characteristics in 88 patients (mean age 55 years) presenting to a community emergency department and to estimate CT sensitivity for these infections. Initial MRI reports were examined for all patients, and a 14 patient subcohort underwent both MRI and CT. Sensitivity from a post hoc blinded CT overread by a neuroradiologist was reported. Prevalence of infection included: spinal epidural abscess/infection (SEA) in 61 (69%), vertebral osteomyelitis/discitis in 54 (61%), septic facet in 15 (17%), and paravertebral abscess/infection in 53 (60%). Of the SEAs, 82% (50/61) were associated with other spinal infections, while 18% (11/61) were isolated SEAs. The overall CT sensitivity in the masked overread was 79% (11/14) for any PSI, 83% (10/12) for any infection outside the spinal canal, and only 18% (2/11) for SEA. The authors conclude that patients found to have vertebral osteomyelitis/discitis, septic facet, and paravertebral infections frequently had a SEA coinfection. CT interpretation by a neuroradiologist had moderate sensitivity for infections outside the spinal canal but low sensitivity for SEA.

Myelopathy and/or major or progressive neurologic deficits:

- Green – **MRI cervical spine without IV contrast** or **MRI cervical spine without and with IV contrast**
- Yellow – **MRI cervical spine with IV contrast**
  [further evaluate abnormalities previously noted on noncontrast imaging]
- Yellow – **CT cervical spine without IV contrast** or **CT myelography cervical spine**
  [*MRI contraindicated or findings indeterminate; intervention planning*]
- Red – **Bone scan**; **PET**; **PET/CT**; **SPECT**; **SPECT/CT; Gallium scan whole body; WBC scan; CT with IV contrast; CT without and with IV contrast**

Level of Evidence: Moderate

Notes concerning use of contrast:
The use of MRI IV contrast is often indicated for cases with new, progressive, or unexplained neurologic deficits, and is useful to characterized abnormalities within the cervical cord or intradural extramedullary space seen on previous MRI without IV contrast. It can also be useful in patients with a history of previous surgery, particularly in the evaluation of recurrent neurologic deficit.

Notes concerning applicability and/or patient preferences:
Consulting and reporting requirements are not required for orders for applicable imaging services made by ordering professionals under the following circumstances (*42 C.F.R. § 414.94. 2015*):

- Emergency services when provided to individuals with emergency medical conditions; or
- For an inpatient and for which payment is made under Medicare Part A.

Guideline and PLE expert panel consensus opinion summary:
Overview:
Myelopathy or major/progressive neurologic deficits are red flags for which urgent diagnostic imaging is recommended (Agarwal et al [*ACR*] 2021; Hegmann et al [*ACOEM*] 2016; PLE expert panel consensus opinion). There is agreement among multiple high-quality guidelines (Bussieres et al 2008; Mummaneni et al 2009; Guzman et al 2009; Agarwal et al [*ACR*] 2021; Hegmann et al [*ACOEM*] 2016) that advanced imaging, preferably with MRI, is indicated in patients with myelopathy or progressive neurologic deficits.

MRI cervical spine:
MRI is recommended as the imaging procedure of choice in patients with new onset or progressive myelopathy, major or progressive neurologic deficits, and to evaluate for compressive lesions in patients with myelopathy or radiculo-myelopathy (Hegmann et al [*ACOEM*] 2016: strength C evidence, high level confidence; Bussieres et al 2008; Guzman et al 2009; Agarwal et al [*ACR*] 2021). MRI is generally preferred over CT as it does not use ionizing radiation and has superior soft tissue contrast, allowing for direct visualization of the cervical cord and intradural lesions, better visualization of surrounding soft tissue structures, and improved detection of vertebral marrow abnormalities (Chou et al [*ACP & APS*] 2007; Agarwal et al [*ACR*] 2021; PLE expert panel consensus opinion). MRI with IV contrast may be useful to characterize intradural and intramedullary abnormalities, and/or to evaluate patients with known neurologic disorders (PLE expert panel consensus opinion). In cases in which spinal cord ischemia is suspected as the cause for acute myelopathy, MRI without and with IV contrast is useful (Agarwal et al [*ACR*] 2021).

CT cervical spine or CT myelography cervical spine:
Although CT demonstrates osseous integrity with excellent assessment of bone destruction, MRI provides better visualization of the marrow and the spinal cord (Agarwal et al [*ACR*] 2021). Therefore, thin section CT or CT myelography is indicated for patients with myelopathy and/or major or progressive neurologic defects who are unable to undergo MRI, who have equivocal findings on MRI, or to plan for injection therapy or surgery (PLE expert panel consensus opinion; Bussières et al 2008; Mummaneni et al 2009: Class II evidence, strength C recommendation). Their use may also be indicated for further evaluation of patients with myelopathy, radiculopathy or myeloradiculopathy with known or suspected OPLL, DISH, or crystal deposition disease (PLE expert panel consensus opinion). CT myelography may be useful in answering specific questions before surgical intervention (Agarwal et al [*ACR*] 2021).

Clinical notes:

- Myelopathy is a clinical diagnosis based on signs and symptoms of spinal cord dysfunction, leading to weakness, numbness, and difficulty with coordination or balance. It can be caused by primary intrinsic disorders of the spinal cord (e.g., neoplastic, infectious, inflammatory), but more commonly by secondary conditions (e.g., degenerative disease) resulting in extrinsic compression of the spinal cord (Agarwal et al [*ACR*] 2021; PLE expert panel consensus opinion).
- Symptoms of myelopathy include loss of coordination, sensory disturbance at multiple levels, gait abnormalities, an acute change in bowel or bladder, and frequent falling (PLE expert panel consensus opinion).
- Signs of myelopathy include hyperreflexia, weakness, Lhermitte sign, clonus, Hoffmann sign, and a positive Babinski sign (PLE expert panel consensus opinion).
- Preoperative MR findings imaging T1 hypointensity combined with T2 hyperintensity at the same level in the cervical cord [indicates cystic myelomalacia and] may predict a poor surgical outcome (Mummaneni et al 2009).

Technical notes:

- MRI examinations of the cervical spine should include the cervico-occipital junction and the upper thoracic spine (PLE expert panel consensus opinion).

Evidence update (2010-present):
High Level of Evidence:
Sun et al (2011) conducted a prospective randomized controlled study to investigate whether intramedullary spinal cord changes in signal intensity on MRI affect surgical opportunity and approach for cervical myelopathy due to ossification of the posterior longitudinal ligament (OPLL). A total of 56 patients (mean age 57.5) were assigned to either anterior decompression/fusion (n = 27) or posterior laminectomy (n = 29). Patients were followed up for an average 20.3 months (range 12-34 months). Clinical outcomes were assessed by the average operative time, blood loss, Japanese Orthopedic Association (JOA) score, improvement rate (IR) and complication. The study found that, regardless of hyperintensity on T2-weighted imaging or hypointensity on T1-weighted imaging in patients with OPLL, severe damage to the spinal cord is indicated. Surgical treatment should be provided before the advent of intramedullary spinal cord changes in signal intensity on MRI. The anterior approach is more effective than posterior approach for treating cervical myelopathy due to OPLL being characterized by intramedullary spinal cord changes in signal intensity on MRI.

Moderate Level of Evidence:
Tetreault et al (2013) conducted a systematic review to determine whether there are MRI characteristics in patients with cervical spondylotic myelopathy that affect treatment decisions or predict postsurgical

outcomes or adverse events. Twenty publications were included (3 assessing MRI predictors of clinical deterioration in conservative treatment; 17 evaluated MRI anatomic or cord characteristics that could predict surgical outcome or adverse events). Results of analysis found low evidence suggesting that high signal intensity (SI) grade on T2WI is not associated with patient deterioration during conservative treatment. There is low evidence identifying number of high SI segments on T2WI, low signal segments on T1WI combined T1/T2 SI, and SI ratio as important negative predictors of surgical outcome. The authors make the following recommendations: 1) We suggest that when clinically feasible, surgeons rely on MRI to confirm the diagnosis of CSM and rely on clinical history and examination to determine progression and severity of disease; 2) T2 signal may be a useful prognostic indicator when used in combination with low SI change on T1WI, or as a ratio comparing compressed with noncompressed segments, or as a ratio of T2 compared with T1WI.

Vendantam et al (2013) conducted a systematic review on different classifications of T2-weighted (T2W) increased signal intensity (ISI) on preoperative MR images of patients with cervical spondylotic myelopathy (CSM). A total of 22 studies were included, including 11 prospective studies (n = 1,508 patients). Methodological variations in previous studies made it difficult to compare studies and results. The authors conclude that: both multisegmental T2W ISI, and sharp intense T2W ISI are associated with poorer surgical outcome (Class II evidence); and the regression of T2W ISI postoperatively correlates with better functional outcomes (Class II evidence).

Low Level of Evidence:
Liao et al (2020) investigated the prevalence of ossification of posterior longitudinal ligament (OPLL) in 7,210 patients with degenerative cervical myelopathy (DCM). All patients underwent cervical spine CT, with diagnosis criterion for OPLL of thickness > 2mm on axial imaging. The authors note that, while MRI can provide favorable soft tissue evidence of spinal cord compression MRI is inadequate for diagnosing OPLL due to similar signal intensity between an ossified lesion and a disc hernia. Overall, prevalence of OPLL was 18.22%, with higher prevalence specifically seen in diabetes mellitus and hypertensive patients (24.16% 22.26%). Comparison by age showed that OPLL prevalence was highest in the 70-79 age group (21.91%). The authors conclude that, given its high prevalence, CT examination is suggested to identify possible OPLL in DCM patients.

History of cervical spine surgery and any of the following:

- **New or progressive symptoms***
- **Suspicion of device or hardware failure**
- **Planning or evaluation for injection therapy or surgery**

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- Yellow – **MRI cervical spine with IV contrast**
  [further evaluate abnormalities previously noted on noncontrast imaging]
- Yellow – **CT myelography cervical spine**
  [*MRI contraindicated or findings indeterminate; intervention planning*]
- Yellow – **Bone scan**, **SPECT, SPECT/CT**
  [*further evaluate or characterize bone lesion(s)*]
- Red – **PET** or **PET/CT; Gallium scan whole body; WBC scan; CT with IV contrast; CT without and with IV contrast**

*For infection-related concerns, see "suspected infection" scenario of this document.

Level of Evidence: Low

Notes concerning use of contrast:
MRI IV contrast is often indicated for cases of suspected cancer or infection, in patients with unexplained neurologic deficits, in patients with a history of prior surgery, or to evaluate abnormalities noted on prior noncontrast imaging.

Guideline and PLE expert panel consensus opinion summary:
Overview:
For patients with previous cervical spine surgery, MRI is considered the gold standard for defining soft tissue anatomy (Bussieres et al 2008; Hegmann et al [*ACOEM*] 2016: level C recommendation, high level of confidence; Bono et al [*NASS*] 2011; McDonald et al [*ACR*] 2019). However, metal artifact may limit MRI assessment of cervical hardware and complications related to position or integrity (McDonald et al [*ACR*] 2019). CT is helpful to assess the integrity of interbody and posterior spinal fusion(s), and to evaluate total disc replacement devices (PLE expert panel consensus opinion). CT myelography can be useful to assess the integrity of interbody and posterior spinal fusion(s), or to evaluate the integrity of disc replacement devices in symptomatic patients (McDonald et al [*ACR*] 2019; PLE expert panel consensus opinion). Bone scintigraphy and SPECT can on occasion be useful to evaluate for the source of neck pain, such as further evaluation of a bone lesion (PLE expert panel consensus opinion).

Technical notes:
- Findings on MRI and CT are nonspecific and require strict correlation of symptoms and findings on physical exam to determine the significance (PLE expert panel consensus opinion).
- CT examinations obtained to evaluate the integrity of spine fusions should utilize thin sections with reformatted sections in the sagittal and coronal or coronal oblique planes (PLE expert panel consensus opinion).

- CT and MRI spine examinations obtained in patients with instrumentation, interbody implants with metallic beads, metallic interbody implants or total disc replacement devices should utilize metal artifact reduction techniques (PLE expert panel consensus opinion).

Evidence update (2015-present):

Moderate Level of Evidence:

Rhee et al (2015) conducted a systematic review to examine best criteria for radiological determination of postoperative subaxial cervical fusion to be applied to current clinical practice. A total of 12 publications were included, and assessed C2 to C7 via anterior or posterior approach, at > 12 weeks postoperative, with any graft or implant. Results found that of advanced imaging modalities, there is moderate evidence that CT is more accurate and reliable than MRI in assessing anterior cervical fusion. The authors recommend that radiographs be the initial method for determining posterior cervical fusion but suggest a lower threshold for obtaining CT scans because dynamic radiographs may not be as useful if spinous processes have been removed by laminectomy.

Guideline exclusions:

- Cases meeting the definition of a suspected or confirmed emergency medical condition
- Staging, follow-up, or surveillance of cancer
- Inflammatory spondyloarthropathy
- MR discography or CT discography
- Pregnant patients and
- Pediatric patients (including development-related dorsopathies and congenital malformations).

AUC Revision History:

Revision Date	New Clinical Scenario	Approval Body
04/18/2017	Initial Document Development	CDI Quality Institute's Multidisciplinary Committee
03/29/2018	N/A	CDI Quality Institute's Multidisciplinary Committee
05/15/2019	N/A	CDI Quality Institute's Multidisciplinary Committee
05/28/2020	N/A	CDI Quality Institute's Multidisciplinary Committee
07/21/2021	History of cervical spine surgery	CDI Quality Institute Multidisciplinary Committee
12/06/2022	N/A	RAYUS Radiology Quality Institute's Multidisciplinary Committee

Information on our evidence development process, including our conflicts of interest policy is available on our website at **https://www.rayusradiology.com/ple**

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Appropriateness of Advanced Imaging in Cervical Spine/Neck Pain Bibliography

12/06/2022

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