American College of Radiology
ACR Appropriateness Criteria®
Cervical Pain or Cervical Radiculopathy

Variant: 1 Adult. Acute or increasing cervical pain without radiculopathy. No trauma or "red flags." Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
Radiography cervical spine	May Be Appropriate	☢☢
Discography cervical spine	Usually Not Appropriate	☢☢
Radiography cervical spine flexion extension lateral views	Usually Not Appropriate	☢☢
Radiographic myelography cervical spine	Usually Not Appropriate	☢☢☢
MRA neck with IV contrast	Usually Not Appropriate	O
MRA neck without and with IV contrast	Usually Not Appropriate	O
MRA neck without IV contrast	Usually Not Appropriate	O
MRI cervical spine with IV contrast	Usually Not Appropriate	O
MRI cervical spine without and with IV contrast	Usually Not Appropriate	O
MRI cervical spine without IV contrast	Usually Not Appropriate	O
Bone scan whole body with SPECT or SPECT/CT cervical spine	Usually Not Appropriate	☢☢☢
CT cervical spine with IV contrast	Usually Not Appropriate	☢☢☢
CT cervical spine without and with IV contrast	Usually Not Appropriate	☢☢☢
CT cervical spine without IV contrast	Usually Not Appropriate	☢☢☢
CTA neck with IV contrast	Usually Not Appropriate	☢☢☢
CT myelography cervical spine	Usually Not Appropriate	☢☢☢☢

Variant: 2 Adult. Acute or increasing cervical pain with radiculopathy. No trauma or "red flags." Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
Radiography cervical spine	May Be Appropriate	☢☢
MRI cervical spine without IV contrast	May Be Appropriate	O
Radiography cervical spine flexion extension lateral views	Usually Not Appropriate	☢☢
Radiographic myelography cervical spine	Usually Not Appropriate	☢☢☢
MRA neck with IV contrast	Usually Not Appropriate	O
MRA neck without and with IV contrast	Usually Not Appropriate	O
MRA neck without IV contrast	Usually Not Appropriate	O
MRI cervical spine with IV contrast	Usually Not Appropriate	O
MRI cervical spine without and with IV contrast	Usually Not Appropriate	O
Bone scan whole body with SPECT or SPECT/CT cervical spine	Usually Not Appropriate	☢☢☢
CT cervical spine with IV contrast	Usually Not Appropriate	☢☢☢
CT cervical spine without and with IV contrast	Usually Not Appropriate	☢☢☢
CT cervical spine without IV contrast	Usually Not Appropriate	☢☢☢
CTA neck with IV contrast	Usually Not Appropriate	☢☢☢
CT myelography cervical spine	Usually Not Appropriate	☢☢☢☢

Variant: 3 **Adult. Prior cervical spine surgery. Acute or increasing mechanical cervical pain or radiculopathy. No trauma or "red flags." Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
Radiography cervical spine	Usually Appropriate	☢☢
Radiography cervical spine flexion extension lateral views	Usually Appropriate	☢☢
MRI cervical spine without IV contrast	Usually Appropriate	O
CT cervical spine without IV contrast	Usually Appropriate	☢☢☢
MRI cervical spine without and with IV contrast	May Be Appropriate	O
CT myelography cervical spine	May Be Appropriate	☢☢☢☢
Discography cervical spine	Usually Not Appropriate	☢☢
Radiographic myelography cervical spine	Usually Not Appropriate	☢☢☢
MRA neck with IV contrast	Usually Not Appropriate	O
MRA neck without and with IV contrast	Usually Not Appropriate	O
MRA neck without IV contrast	Usually Not Appropriate	O
MRI cervical spine with IV contrast	Usually Not Appropriate	O
Bone scan whole body with SPECT or SPECT/CT cervical spine	Usually Not Appropriate	☢☢☢
CT cervical spine with IV contrast	Usually Not Appropriate	☢☢☢
CT cervical spine without and with IV contrast	Usually Not Appropriate	☢☢☢
CTA neck with IV contrast	Usually Not Appropriate	☢☢☢

Variant: 4 **Adult. Suspected or known infection with acute or increasing cervical pain or radiculopathy. No trauma. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
MRI cervical spine without and with IV contrast	Usually Appropriate	O
MRI cervical spine without IV contrast	May Be Appropriate	O
CT cervical spine with IV contrast	May Be Appropriate	☢☢☢
CT cervical spine without IV contrast	May Be Appropriate	☢☢☢
Discography cervical spine	Usually Not Appropriate	☢☢
Radiography cervical spine	Usually Not Appropriate	☢☢
Radiography cervical spine flexion extension lateral views	Usually Not Appropriate	☢☢
Radiographic myelography cervical spine	Usually Not Appropriate	☢☢☢
MRA neck with IV contrast	Usually Not Appropriate	O
MRA neck without and with IV contrast	Usually Not Appropriate	O
MRA neck without IV contrast	Usually Not Appropriate	O
MRI cervical spine with IV contrast	Usually Not Appropriate	O
Bone scan whole body with SPECT or SPECT/CT cervical spine	Usually Not Appropriate	☢☢☢
CT cervical spine without and with IV contrast	Usually Not Appropriate	☢☢☢
CTA neck with IV contrast	Usually Not Appropriate	☢☢☢
CT myelography cervical spine	Usually Not Appropriate	☢☢☢☢
FDG-PET/CT skull base to mid-thigh	Usually Not Appropriate	☢☢☢☢
Gallium scan whole body	Usually Not Appropriate	☢☢☢☢
WBC scan whole body	Usually Not Appropriate	☢☢☢☢

Variant: 5 **Adult. Diagnosis of malignancy with acute or increasing cervical pain or**

radiculopathy. No trauma. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
MRI cervical spine without and with IV contrast	Usually Appropriate	O
MRI cervical spine without IV contrast	May Be Appropriate	O
CT cervical spine with IV contrast	May Be Appropriate (Disagreement)	☢☢☢
CT cervical spine without IV contrast	May Be Appropriate (Disagreement)	☢☢☢
FDG-PET/CT whole body	May Be Appropriate	☢☢☢☢
Discography cervical spine	Usually Not Appropriate	☢☢
Radiography cervical spine	Usually Not Appropriate	☢☢
Radiography cervical spine flexion extension lateral views	Usually Not Appropriate	☢☢
Radiographic myelography cervical spine	Usually Not Appropriate	☢☢☢
MRA neck with IV contrast	Usually Not Appropriate	O
MRA neck without and with IV contrast	Usually Not Appropriate	O
MRA neck without IV contrast	Usually Not Appropriate	O
MRI cervical spine with IV contrast	Usually Not Appropriate	O
Bone scan whole body with SPECT or SPECT/CT cervical spine	Usually Not Appropriate	☢☢☢
CT cervical spine without and with IV contrast	Usually Not Appropriate	☢☢☢
CTA neck with IV contrast	Usually Not Appropriate	☢☢☢
FDG-PET/MRI skull base to mid-thigh	Usually Not Appropriate	☢☢☢
FDG-PET/MRI whole body	Usually Not Appropriate	☢☢☢
CT myelography cervical spine	Usually Not Appropriate	☢☢☢☢
Fluoride PET/CT whole body	Usually Not Appropriate	☢☢☢☢

Variant: 6 Adult. Suspected cervicogenic headache. No neurologic deficit. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
MRI cervical spine without IV contrast	May Be Appropriate (Disagreement)	O
Radiography cervical spine	Usually Not Appropriate	☢☢
Radiography cervical spine flexion extension lateral views	Usually Not Appropriate	☢☢
Radiographic myelography cervical spine	Usually Not Appropriate	☢☢☢
MRA neck with IV contrast	Usually Not Appropriate	O
MRA neck without and with IV contrast	Usually Not Appropriate	O
MRA neck without IV contrast	Usually Not Appropriate	O
MRI cervical spine with IV contrast	Usually Not Appropriate	O
MRI cervical spine without and with IV contrast	Usually Not Appropriate	O
Bone scan whole body with SPECT or SPECT/CT cervical spine	Usually Not Appropriate	☢☢☢
CT cervical spine with IV contrast	Usually Not Appropriate	☢☢☢
CT cervical spine without and with IV contrast	Usually Not Appropriate	☢☢☢
CT cervical spine without IV contrast	Usually Not Appropriate	☢☢☢
CTA neck with IV contrast	Usually Not Appropriate	☢☢☢
CT myelography cervical spine	Usually Not Appropriate	☢☢☢☢

Variant: 7 Adult. Chronic cervical pain without radiculopathy. No trauma or "red flags." Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level

Radiography cervical spine	May Be Appropriate	☢☢
MRI cervical spine without IV contrast	May Be Appropriate	O
Discography cervical spine	Usually Not Appropriate	☢☢
Radiography cervical spine flexion extension lateral views	Usually Not Appropriate	☢☢
Radiographic myelography cervical spine	Usually Not Appropriate	☢☢☢
MRA neck with IV contrast	Usually Not Appropriate	O
MRA neck without and with IV contrast	Usually Not Appropriate	O
MRA neck without IV contrast	Usually Not Appropriate	O
MRI cervical spine with IV contrast	Usually Not Appropriate	O
MRI cervical spine without and with IV contrast	Usually Not Appropriate	O
Bone scan whole body with SPECT or SPECT/CT cervical spine	Usually Not Appropriate	☢☢☢
CT cervical spine with IV contrast	Usually Not Appropriate	☢☢☢
CT cervical spine without and with IV contrast	Usually Not Appropriate	☢☢☢
CT cervical spine without IV contrast	Usually Not Appropriate	☢☢☢
CTA neck with IV contrast	Usually Not Appropriate	☢☢☢
CT myelography cervical spine	Usually Not Appropriate	☢☢☢☢

Variant: 8 Adult. Chronic cervical pain with radiculopathy. No trauma or "red flags." Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
MRI cervical spine without IV contrast	Usually Appropriate	O
Radiography cervical spine	May Be Appropriate (Disagreement)	☢☢
CT cervical spine without IV contrast	May Be Appropriate	☢☢☢
Discography cervical spine	Usually Not Appropriate	☢☢
Radiography cervical spine flexion extension lateral views	Usually Not Appropriate	☢☢
Radiographic myelography cervical spine	Usually Not Appropriate	☢☢☢
MRA neck with IV contrast	Usually Not Appropriate	O
MRA neck without and with IV contrast	Usually Not Appropriate	O
MRA neck without IV contrast	Usually Not Appropriate	O
MRI cervical spine with IV contrast	Usually Not Appropriate	O
MRI cervical spine without and with IV contrast	Usually Not Appropriate	O
Bone scan whole body with SPECT or SPECT/CT cervical spine	Usually Not Appropriate	☢☢☢
CT cervical spine with IV contrast	Usually Not Appropriate	☢☢☢
CT cervical spine without and with IV contrast	Usually Not Appropriate	☢☢☢
CTA neck with IV contrast	Usually Not Appropriate	☢☢☢
CT myelography cervical spine	Usually Not Appropriate	☢☢☢☢

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Summary of Literature Review

Introduction/Background

Cervical or neck pain has an extensive impact on both individuals and society extending beyond the physical factors to also involve physiological and socioeconomic factors [1-3]. Neck pain is 1 of the top 5 leading causes of global years lost to disability [1-4]. The 2019 Global Burden of Disease Data estimates the prevalence, incidence, and years lost to disability of neck pain at 222.7 million, 47.5 million, and 22.1 million, respectively [5,6], with North America ranking in the top 5 in all 3 metrics [6]. It is important to note that prevalence of neck pain is heterogenous between studies due to multiple factors but ranges between 15% and 50% annually [1,2,7], with nearly 50% of individuals experiencing recurrent or persistent symptoms [1]. The economic burden is equally profound, with low back pain and neck pain expenditure in 2016 approaching $134.5 billion, the highest health care expenditure in the United States of all conditions assessed [8].

The pathophysiology and differential diagnosis of cervical or neck pain is influenced by multiple factors including duration of symptoms (acute, subacute, or chronic), nature of symptoms (neuropathic versus nonneuropathic), presence of systemic symptoms (malignancy, autoimmune disease, etc), and associated laboratory abnormalities (infection, malignancy, inflammatory, etc) [4,9]. It is important to acknowledge all these factors when considering imaging of the cervical spine for cervical or neck pain. Furthermore, if a different disease entity is suspected, the reader is referenced to additional ACR Appropriateness Criteria documents discussing these conditions that are beyond the scope of this document. Imaging in the setting of spine trauma should be guided by the ACR Appropriateness Criteria® topic on "Suspected Spine Trauma" [10]. The presence of a neck mass or lymphadenopathy should be guided by the ACR Appropriateness Criteria® topic on "Neck Mass/Adenopathy" [11]. Neuropathic symptoms should be clarified by examination to exclude myelopathy or plexopathy, guided by the ACR Appropriateness Criteria® topic on "Myelopathy" [12] and the ACR Appropriateness Criteria® topic on "Plexopathy" [13], respectively. Evaluation of cervicogenic headache may overlap with symptoms addressed in the ACR Appropriateness Criteria® topic on "Headache" [14]. The presence of clinical signs or symptoms suggesting meningitis, neck soft-tissue infection, or upper respiratory infection should be managed on clinical guidelines separate from this review of cervical neck pain.

Establishing the underlying cause of nontraumatic cervical or neck pain is of greatest importance to optimize and direct management and avoid delay of care for urgent cases. Mechanical pain originating from the spine and/or its supporting structures represents the majority of nontraumatic cervical or neck pain. Cervical neuropathic pain, including radiculopathy, is the primary consideration of mechanical pain [1]. Additional important etiologies include tumor, infection, inflammation, autoimmune, headache, and vascular causes [1,15]. Therefore, the combination of the patient's medical history and clinical expertise is critical to optimize imaging of the neck or cervical pain.

Imaging of nontraumatic cervical or neck pain remains challenging and costly with a lack of validated guidelines [16,17]. In cervical trauma, imaging of the cervical spine is guided by multiple validated criteria [18-21]. In low back pain, a system of "red flags" has been adopted to aid the clinicians in managing nonemergent patients [22-26]. A similar system, although not validated, has been proposed in cervical or neck pain to help in imaging triage of nonemergent patients and includes increased risk for fracture, malignancy, constitution symptoms (fever, weight loss),

infection, increased risk of infection (immunosuppression, intravenous [IV] drug use), inflammatory arthritis, vascular etiology suspected, spinal cord injury or deficit, coagulopathy, and/or elevated inflammatory markers (white blood cell [WBC] count, erythrocyte sedimentation rate [ESR], C-reactive protein [CRP]) [1,4,9].

Special Imaging Considerations

CT myelography has supplanted fluoroscopic myelography in most circumstances; however, there may be times when fluoroscopic myelography is also performed before CT imaging. For this document, the procedure "CT myelography" is used to guide referral to the radiologist.

Recent advances in CT imaging offer promise in optimizing spine imaging including diagnosis and dose reduction. Dual-energy CT offers added value in assessment of disc space, metastasis, fractures, metal reduction, and gout [27-30]. Also, the recent development of photon counting CT offers great potential in spine imaging including sharper images and increase in confident diagnosis [31]. However, whereas these advancements offer great potential in spine imaging including cervical or neck pain, further data are needed before incorporation of these techniques in this document.

Similarly, advancement in MRI including functional imaging, artificial intelligence, and diffusion kurtosis offers exciting tools to potentially aid in understanding the neuropathology of neck pain, alterations in brain volumes and neuronal connectivity in patients with neck pain, and cervical nerve roots fiber thickness alteration in radiculopathy and aid in diagnosis and optimization of workflow [32-36]. However, these advanced imaging tools remain in the early phase of clinical use and validation and, therefore, will not be incorporated in this document.

Initial Imaging Definition

Initial imaging is defined as imaging at the beginning of the care episode for the medical condition defined by the variant. More than one procedure can be considered usually appropriate in the initial imaging evaluation when:

- There are procedures that are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care)

OR

- There are complementary procedures (ie, more than one procedure is ordered as a set or simultaneously wherein each procedure provides unique clinical information to effectively manage the patient's care).

Discussion of Procedures by Variant

Variant 1: Adult. Acute or increasing cervical pain without radiculopathy. No trauma or "red flags." Initial imaging.

Acute neck pain, <6 weeks in duration, is a common complaint with a prevalence of 10% to 15% [37]. Although most patients' symptoms resolve or significantly improve at 1 year, approximately 50% of patients continue to complain of symptoms at 1-year follow-up [1,37]. Prognostic factors

include age, sex, severity of pain, prior neck pain, previous trauma, and degenerative disease [38,39].

A detailed clinical history and physical examination is frequently all that is needed for assessment of acute neck or cervical pain [39,40]. Imaging may be useful if "red flag" symptoms are present or suspected. "Red flag" symptoms include risk for fracture, malignancy, constitution symptoms (fever, weight loss), infection, increased risk of infection (immunosuppression, IV drug use), inflammatory arthritis, vascular etiology suspected, spinal cord injury or deficit, coagulopathy, and/or elevated inflammatory markers (WBC, ESR, CRP) [1,4,9,40].

Variant 1: Adult. Acute or increasing cervical pain without radiculopathy. No trauma or "red flags." Initial imaging.
A. Bone scan whole body with SPECT or SPECT/CT cervical spine

There is currently no evidence to support the use of nuclear medicine studies as the initial imaging modalities for acute cervical or neck pain in the absence of "red flag" symptoms. Bone scan offers a very sensitive modality for the detection of spinal pathology and often detects functional and metabolic changes before anatomical changes noted on radiographs, CT, and MRI [41]. However, bone scan lacks both sensitivity and spatial resolution [41]. Combined single-photon emission CT (SPECT)/CT overcomes spatial resolution limitation [41], but prospective studies assessing its role in acute neck or cervical pain are lacking.

Variant 1: Adult. Acute or increasing cervical pain without radiculopathy. No trauma or "red flags." Initial imaging.
B. CT cervical spine with IV contrast

CT offers superior depiction of the bones relative to radiographs, in particular, structures relevant to degenerative disease such as end plates, disc space, and facet joints [42,43]. The advancement of new CT techniques such as dual-energy CT and photon counting offers promising dose reduction scanning parameters [44,45]. However, currently this has not gained widespread use and has not been extensively studied in a neck or cervical pain population. The addition of IV contrast does not add significant value in the absence of "red flag" symptoms in this clinical scenario.

Variant 1: Adult. Acute or increasing cervical pain without radiculopathy. No trauma or "red flags." Initial imaging.
C. CT cervical spine without and with IV contrast

There is no relevant literature to support the use of CT cervical spine without and with IV contrast in the initial imaging of acute or increasing cervical pain without radiculopathy.

Variant 1: Adult. Acute or increasing cervical pain without radiculopathy. No trauma or "red flags." Initial imaging.
D. CT cervical spine without IV contrast

CT offers superior depiction of the bones relative to radiographs, in particular, structures relevant to degenerative disease such as end plates, disc space, and facet joints [42,43]. The advancement of new CT techniques such as dual-energy CT and photon counting offers promising dose reduction scanning parameters [44,45]. However, currently this has not gained widespread use and has not been extensively studied in neck or cervical pain population.

Variant 1: Adult. Acute or increasing cervical pain without radiculopathy. No trauma or "red flags." Initial imaging.
E. CT myelography cervical spine

In the absence of radiographic abnormalities or neurological symptoms, myelography is not useful as a first-line imaging modality in this clinical scenario.

Variant 1: Adult. Acute or increasing cervical pain without radiculopathy. No trauma or "red flags." Initial imaging.
F. CTA neck with IV contrast

In the absence of neurological symptoms or concern for vascular pathology "red flag" symptoms, CT angiography (CTA) is not useful as a first-line imaging test.

Variant 1: Adult. Acute or increasing cervical pain without radiculopathy. No trauma or "red flags." Initial imaging.
G. Discography cervical spine

The literature search did not identify any studies regarding the use of discography as a first-line test in the evaluation of this clinical setting.

Variant 1: Adult. Acute or increasing cervical pain without radiculopathy. No trauma or "red flags." Initial imaging.
H. MRA neck with IV contrast

In the absence of neurological symptoms or concern for vascular pathology "red flag" symptoms, MR angiography (MRA) neck with IV contrast is not useful as a first-line imaging modality in this clinical scenario.

Variant 1: Adult. Acute or increasing cervical pain without radiculopathy. No trauma or "red flags." Initial imaging.
I. MRA neck without and with IV contrast

In the absence of neurological symptoms or concern for vascular pathology "red flag" symptoms, MRA neck with and without IV contrast is not useful as a first-line imaging modality in this clinical scenario.

Variant 1: Adult. Acute or increasing cervical pain without radiculopathy. No trauma or "red flags." Initial imaging.
J. MRA neck without IV contrast

In the absence of neurological symptoms or concern for vascular pathology "red flag" symptoms, MRA neck without IV contrast is not useful as a first-line imaging modality in this clinical scenario.

Variant 1: Adult. Acute or increasing cervical pain without radiculopathy. No trauma or "red flags." Initial imaging.
K. MRI cervical spine with IV contrast

MRI cervical spine with IV contrast is not useful as a separate examination without the precontrast sequences in this clinical scenario.

Variant 1: Adult. Acute or increasing cervical pain without radiculopathy. No trauma or "red flags." Initial imaging.
L. MRI cervical spine without and with IV contrast

MRI is the most sensitive imaging modality for the assessment of soft tissue abnormalities, including cervical spine soft tissues [1,46]. However, a high rate of detected abnormalities is noted in asymptomatic patients, or abnormalities are not associated with acute symptoms [1,47]. Therefore, in the absence of "red flag" symptoms, MRI is not useful as a first-line imaging modality in this clinical scenario. The addition of contrast in this scenario also is not considered useful if

there is no concern for "red flag" symptoms.

Variant 1: Adult. Acute or increasing cervical pain without radiculopathy. No trauma or "red flags." Initial imaging.
M. MRI cervical spine without IV contrast

MRI is the most sensitive imaging modality for the assessment of soft tissue abnormalities, including cervical spine soft tissues [1,46]. However, a high rate of detected abnormalities is noted in asymptomatic patients, or abnormalities are not associated with acute symptoms [1,47]. Therefore, in the absence of "red flag" symptoms, MRI is not useful as a first-line imaging modality in this clinical scenario.

Variant 1: Adult. Acute or increasing cervical pain without radiculopathy. No trauma or "red flags." Initial imaging.
N. Radiographic myelography cervical spine

In the absence of radiographic abnormalities or neurological symptoms, myelography is not useful as a first-line imaging modality in this clinical scenario.

Variant 1: Adult. Acute or increasing cervical pain without radiculopathy. No trauma or "red flags." Initial imaging.
O. Radiography cervical spine

Radiographs are frequently ordered as the first imaging modality for the assessment of acute neck and cervical pain [48]. Spine radiographs are useful in the initial assessment and screening of spondylosis, degenerative disc disease, and malalignment. However, radiographs are often not needed in the acute setting in the absence of "red flag" symptoms and do not influence management or improve clinical outcome [48,49]. The literature search did not identify any studies regarding the use of flexion and extension views as a first-line imaging modality in this clinical scenario.

Variant 1: Adult. Acute or increasing cervical pain without radiculopathy. No trauma or "red flags." Initial imaging.
P. Radiography cervical spine flexion extension lateral views

Radiographs are frequently ordered as the first imaging modality for the assessment of acute neck and cervical pain [48]. Spine radiographs are useful in the initial assessment and screening of spondylosis, degenerative disc disease, and malalignment. However, radiographs are often not needed in the acute setting in the absence of "red flag" symptoms and do not influence management or improve clinical outcome [48,49]. The literature search did not identify any studies regarding the use of flexion and extension views as a first-line imaging modality in this clinical scenario.

Variant 2: Adult. Acute or increasing cervical pain with radiculopathy. No trauma or "red flags." Initial imaging.

Cervical radiculopathy is 1 of the more common causes of neck or cervical pain. Cervical radiculopathy is a relatively common syndrome, with an annual age-adjusted incidence of radiculopathy of 83 per 100,000 persons [50,51]. Cervical radiculopathy is characterized by upper limb pain or sensorimotor deficit secondary to cervical nerve root impingement and/or irritation [50,52]. It frequently presents as neck and/or upper limb pain with or without varying degrees of sensory or motor deficits [50]. The cervical nerve irritation or compression can be secondary to soft disc (herniated disc), hard disc (spondylarthrosis such as facet or uncovertebral joints), or a combination of both [50,53]. Diagnosis of cervical radiculopathy is achieved by a combination of

clinical history, physical examination, and imaging. However, a systemic review assessing the value of physical tests in diagnosis of cervical radiculopathy in comparison to the reference standard of imaging or surgery found limited evidence for the accuracy of physical examinations for the diagnosis of cervical radiculopathy [54]. MRI alone should not be used to diagnose symptomatic cervical radiculopathy and should always be interpreted in combination with the clinical findings given frequent false-positive and false-negative MRI findings [55].

The majority of acute cervical radiculopathy resolves spontaneously or with conservative management [50,56]. This is true for both herniated disc and osteophytes [50], and cervical herniated discs have been noted to diminish in size over time on both CT and MRI [57-59]. Therefore, imaging of acute cervical radiculopathy in the absence of "red flag" symptoms may not be indicated. Furthermore, spondylotic changes of spine are frequently encountered on imaging in asymptomatic patients [46,47,60,61].

Variant 2: Adult. Acute or increasing cervical pain with radiculopathy. No trauma or "red flags." Initial imaging.
A. Bone scan whole body with SPECT or SPECT/CT cervical spine

There is currently no evidence to support the use of nuclear medicine studies as the initial imaging modalities for acute cervical radiculopathy. Bone scan lacks both sensitivity and spatial resolution to detect pathology related to nerve root compression and/or irritation [41]. Combined SPECT/CT overcomes spatial resolution limitation [41], but prospective studies assessing its role in acute cervical radiculopathy are lacking.

Variant 2: Adult. Acute or increasing cervical pain with radiculopathy. No trauma or "red flags." Initial imaging.
B. CT cervical spine with IV contrast

CT offers superior depiction of the bones relative to radiographs, in particular, potential nerve impinging osseous structures such as osteophytes, uncovertebral joints, and facet joints [42,43]. However, CT is less sensitive for the evaluation of nerve root compression, in particular, in cases of herniated disc relative to MRI [62,63]. The advancement of new CT techniques such as dual-energy CT and photon counting offers promising dose reduction scanning parameters [44,45]. However, currently this has not gained widespread use and has not been extensively studied in the neck or cervical pain population. The addition of IV contrast does not add significant value in the absence of "red flag" symptoms in this clinical scenario.

Variant 2: Adult. Acute or increasing cervical pain with radiculopathy. No trauma or "red flags." Initial imaging.
C. CT cervical spine without and with IV contrast

There is no relevant literature to support the use of CT cervical spine without and with IV contrast in the initial imaging of acute or increasing cervical pain with radiculopathy.

Variant 2: Adult. Acute or increasing cervical pain with radiculopathy. No trauma or "red flags." Initial imaging.
D. CT cervical spine without IV contrast

CT offers superior depiction of the bones relative to radiographs, in particular, potential nerve impinging osseous structures such as osteophytes, uncovertebral joints, and facet joints [42,43]. However, CT is less sensitive for the evaluation of nerve root compression, in particular, in cases of herniated disc relative to MRI [62,63]. The advancement of new CT techniques such as dual-energy

CT and photon counting offers promising dose reduction scanning parameters [44,45]. However, currently this has not gained widespread use and has not been extensively studied in neck or cervical pain population.

Variant 2: Adult. Acute or increasing cervical pain with radiculopathy. No trauma or "red flags." Initial imaging.
E. CT myelography cervical spine

The usefulness of CT myelography has significantly decreased with the advent of MRI, which has supplanted CT myelography as a first-line imaging modality for assessment of cervical radiculopathy [64,65]. CT myelography offers similar advantages to CT in assessment of osseous structures. Also, CT myelography images are obtained at higher spatial resolution than MRI and offer excellent depiction of the thecal sac and small nerve roots [66]. CT myelography also offers an excellent alternative to MRI in claustrophobic patients [66].

Variant 2: Adult. Acute or increasing cervical pain with radiculopathy. No trauma or "red flags." Initial imaging.
F. CTA neck with IV contrast

The literature search did not identify any studies regarding the use of CTA neck in the evaluation of this clinical scenario.

Variant 2: Adult. Acute or increasing cervical pain with radiculopathy. No trauma or "red flags." Initial imaging.
G. MRA neck with IV contrast

The literature search did not identify any studies regarding the use of MRA neck with IV contrast in the evaluation of this clinical scenario.

Variant 2: Adult. Acute or increasing cervical pain with radiculopathy. No trauma or "red flags." Initial imaging.
H. MRA neck without and with IV contrast

The literature search did not identify any studies regarding the use of MRA neck without and with IV contrast in the evaluation of this clinical scenario.

Variant 2: Adult. Acute or increasing cervical pain with radiculopathy. No trauma or "red flags." Initial imaging.
I. MRA neck without IV contrast

The literature search did not identify any studies regarding the use of MRA neck without IV contrast in the evaluation of this clinical scenario.

Variant 2: Adult. Acute or increasing cervical pain with radiculopathy. No trauma or "red flags." Initial imaging.
J. MRI cervical spine with IV contrast

MRI cervical spine with IV contrast is not useful as a separate examination without the precontrast sequences in this clinical scenario.

Variant 2: Adult. Acute or increasing cervical pain with radiculopathy. No trauma or "red flags." Initial imaging.
K. MRI cervical spine without and with IV contrast

MRI is the most sensitive imaging modality for assessment of soft tissue abnormalities, including cervical spine soft tissues [1,46]. Also, MRI offers high spatial resolution [67]. Therefore, MRI has

become the modality of choice for the assessment of suspected nerve root impingement [67]. In a 1998 retrospective study of 34 patients with clinically diagnosed cervical radiculopathy and subsequent surgery, Brown et al [68] reported that preoperative MRI correctly predicted 88% of the lesions as opposed to 81% for CT myelography, 57% for myelography, and 50% for CT. These findings continue to hold true in more recent studies comparing CT myelography and MRI in cervical spine degenerative disorders for the detection of disc abnormality and nerve root compression [69]. However, as noted previously, MRI demonstrates frequent false-negative and false-positive findings [55]. Also, MRI is frequently positive in asymptomatic patients, detected abnormalities are not always associated with acute symptoms [47], and abnormal levels on MRI do not always correspond to abnormal clinical-physical examination levels [70]. The addition of contrast in this scenario is not considered useful if there is no concern for "red flag" symptoms.

Variant 2: Adult. Acute or increasing cervical pain with radiculopathy. No trauma or "red flags." Initial imaging.
L. MRI cervical spine without IV contrast

MRI is the most sensitive imaging modality for assessment of soft tissue abnormalities, including cervical spine soft tissues [1,46]. Also, MRI offers high spatial resolution [67]. Therefore, MRI is useful for the assessment of suspected nerve root impingement [67]. In a 1998 retrospective study of 34 patients with clinically diagnosed cervical radiculopathy and subsequent surgery, Brown et al [68] reported that preoperative MRI correctly predicted 88% of the lesions as opposed to 81% for CT myelography, 57% for myelography, and 50% for CT. These findings continue to hold true in more recent studies comparing CT myelography and MRI in cervical spine degenerative disorders for the detection of disc abnormality and nerve root compression [69]. However, as noted previously, MRI demonstrates frequent false-negative and false-positive findings [55]. Also, MRI is frequently positive in asymptomatic patients, detected abnormalities are not always associated with acute symptoms [47], and abnormal levels on MRI do not always correspond to abnormal clinical-physical examination levels [70].

Variant 2: Adult. Acute or increasing cervical pain with radiculopathy. No trauma or "red flags." Initial imaging.
M. Radiographic myelography cervical spine

CT myelography has supplanted radiographic myelography in this clinical scenario. Radiographic myelography is not useful as a first-line imaging modality for this clinical scenario.

Variant 2: Adult. Acute or increasing cervical pain with radiculopathy. No trauma or "red flags." Initial imaging.
N. Radiography cervical spine

Radiographs are frequently acquired in patients with cervical radiculopathy. In a study of 1,581 patients between 18 and 97 years of age, 53.9% of individuals demonstrated disc degenerative changes with prevalence and severity increasing with age [67]. However, the association of these findings with clinical symptoms remains unclear [67]. The addition of flexion and extension views may be helpful in detection of degenerative cervical spondylolisthesis in suspected cases of instability [71].

Variant 2: Adult. Acute or increasing cervical pain with radiculopathy. No trauma or "red flags." Initial imaging.
O. Radiography cervical spine flexion extension lateral views

Radiographs are frequently acquired in patients with cervical radiculopathy. In a study of 1,581

patients between 18 and 97 years of age, 53.9% of individuals demonstrated disc degenerative changes with the prevalence and severity increasing with age [67]. However, the association of these findings with clinical symptoms remains unclear [67]. The addition of flexion and extension views may be helpful in detection of degenerative cervical spondylolisthesis in suspected cases of instability [71].

Variant 3: Adult. Prior cervical spine surgery. Acute or increasing mechanical cervical pain or radiculopathy. No trauma or "red flags." Initial imaging.

Open surgery, endoscopic surgery, and minimally invasive procedures for treatment of cervical spine pathology are relatively common procedures and the rate of instrumented spine fusion continues to increase [72,73]. Discussion of different types of surgeries and their indications are beyond the scope of this document. The readers are advised to review specific procedure literature as needed. Surgical complications include pseudoarthrosis, adjacent segment accelerated degenerative disease, and hardware complications. Pseudoarthrosis varies depending on the type of surgery but is estimated to occur in 2.6% of patients treated with anterior fusion and cervical discectomy [74] and historically is considered the reference standard procedure for treatment of cervical pathology [75]. Adjacent segment accelerated degenerative disease is another potential complication, with reported annual incidence of 3.1% for total disc replacement [76] and rates of reoperation of 22.2% at 10 years for anterior cervical arthrodesis [77]. Please refer to Variant 4 for discussion of suspected cervical spine infection.

Variant 3: Adult. Prior cervical spine surgery. Acute or increasing mechanical cervical pain or radiculopathy. No trauma or "red flags." Initial imaging.
A. Bone scan whole body with SPECT or SPECT/CT cervical spine

There is currently no evidence to support the use of nuclear medicine studies as the initial imaging modalities for acute or increasing mechanical cervical pain or radiculopathy after cervical spine surgery. Bone scan lacks both sensitivity and spatial resolution to detect pathology related to nerve root compression and/or irritation in the postsurgical setting [41]. Furthermore, bone scans can remain positive for years after spinal hardware surgeries, limiting their interpretation [78]. Combined SPECT/CT overcomes spatial resolution limitation [41] and has high sensitivity in identifying postoperative complications such as pseudoarthrosis, hardware failure/loosening, and radiographically occult fractures [79,80]. However, SPECT cannot assess disc herniation, nerve root impingement, stenosis, or listhesis [81].

Variant 3: Adult. Prior cervical spine surgery. Acute or increasing mechanical cervical pain or radiculopathy. No trauma or "red flags." Initial imaging.
B. CT cervical spine with IV contrast

CT is widely considered the most sensitive and specific modality for the assessment of spinal fusion [82-85]. This is enhanced by the advancement in CT technology including multiplanar reformats, metal artifact reduction, and advancement in dose reduction techniques [85,86]. CT offers an advantage to radiographs in its ability to detect adjacent segment degenerative disease following anterior cervical discectomy and fusion (ACDF) [83]. CT allows for assessment of the hardware relationship to bones, nerves, spinal canal, and bone continuity at the fusion site [72]. CT offers superior ability to radiographs in the detection of bridging trabeculation in cages [87]. Derakhshan et al [83] demonstrated that in a study of 690 patients with ACDF, CT altered treatment in 60% of patients with abnormal imaging and persistent symptoms and 39% of patients with persistent symptoms only. Furthermore, the study showed that patients without an indication for imaging are more likely to have negative CTs and less likely to have alteration in treatment course [83]. Lastly,

recent advances in CT imaging techniques including dual-energy CT and photon counting CT offers benefits for expanded future CT use given potential in decreasing metal artifact and increasing image sharpness [27-30]. The addition of contrast may be helpful in differentiation of fibrosis from recurrent/residual disc material [88].

Variant 3: Adult. Prior cervical spine surgery. Acute or increasing mechanical cervical pain or radiculopathy. No trauma or "red flags." Initial imaging.
C. CT cervical spine without and with IV contrast

There is no relevant literature to support the use of CT cervical spine without and with IV contrast in the initial imaging of acute or increasing mechanical cervical pain or radiculopathy in patients with prior cervical spine surgery.

Variant 3: Adult. Prior cervical spine surgery. Acute or increasing mechanical cervical pain or radiculopathy. No trauma or "red flags." Initial imaging.
D. CT cervical spine without IV contrast

CT is widely considered the most sensitive and specific modality for the assessment of spinal fusion [82-85]. This is enhanced by the advancement in CT technology including multiplanar reformats, metal artifact reduction, and advancement in dose reduction techniques [85,86]. CT offers an advantage to radiographs in its ability to detect adjacent segment degenerative disease following ACDF [83]. CT allows for assessment of the hardware relationship to bones, nerves, spinal canal, and bone continuity at the fusion site [72]. CT offers superior ability to radiographs in the detection of bridging trabeculation in cages [87]. Derakhshan et al [83] demonstrated that in a study of 690 patients with ACDF, CT altered treatment in 60% of patients with abnormal imaging and persistent symptoms and 39% of patients with persistent symptoms only. Furthermore, the study showed that patients without indication for imaging are more likely to have negative CTs and less likely to have alteration in treatment course [83]. Lastly, recent advances in CT imaging techniques including dual-energy CT and photon counting CT offers benefits for expanded future CT use given potential in decreasing metal artifact and increasing image sharpness [27-30].

Variant 3: Adult. Prior cervical spine surgery. Acute or increasing mechanical cervical pain or radiculopathy. No trauma or "red flags." Initial imaging.
E. CT myelography cervical spine

The usefulness of CT myelography has significantly decreased with the advent of MRI [64,65]. CT myelography offers similar advantages to CT in the assessment of osseous structures. CT myelography also offers an excellent alternative to MRI in claustrophobic patients [66]. CT myelogram offers an excellent alternative to MRI in assessing the spinal canal and neural foramina in degenerative disease when MRI is nondiagnostic secondary to extensive hardware artifact [65,66].

Variant 3: Adult. Prior cervical spine surgery. Acute or increasing mechanical cervical pain or radiculopathy. No trauma or "red flags." Initial imaging.
F. CTA neck with IV contrast

The literature search did not identify any studies regarding the use of CTA neck in the evaluation of this clinical scenario.

Variant 3: Adult. Prior cervical spine surgery. Acute or increasing mechanical cervical pain or radiculopathy. No trauma or "red flags." Initial imaging.
G. Discography cervical spine

The literature search did not identify any studies regarding the use of discography in the

evaluation of this clinical scenario.

Variant 3: Adult. Prior cervical spine surgery. Acute or increasing mechanical cervical pain or radiculopathy. No trauma or "red flags." Initial imaging.
H. MRA neck with IV contrast

The literature search did not identify any studies regarding the use of MRA neck with IV contrast in the evaluation of this clinical scenario.

Variant 3: Adult. Prior cervical spine surgery. Acute or increasing mechanical cervical pain or radiculopathy. No trauma or "red flags." Initial imaging.
I. MRA neck without and with IV contrast

The literature search did not identify any studies regarding the use of MRA neck without and with IV contrast in the evaluation of this clinical scenario.

Variant 3: Adult. Prior cervical spine surgery. Acute or increasing mechanical cervical pain or radiculopathy. No trauma or "red flags." Initial imaging.
J. MRA neck without IV contrast

The literature search did not identify any studies regarding the use of MRA neck without IV contrast in the evaluation of this clinical scenario.

Variant 3: Adult. Prior cervical spine surgery. Acute or increasing mechanical cervical pain or radiculopathy. No trauma or "red flags." Initial imaging.
K. MRI cervical spine with IV contrast

MRI cervical spine with IV contrast is not useful as a separate examination without the precontrast sequences in this clinical scenario.

Variant 3: Adult. Prior cervical spine surgery. Acute or increasing mechanical cervical pain or radiculopathy. No trauma or "red flags." Initial imaging.
L. MRI cervical spine without and with IV contrast

Hardware metal artifact limits assessment of the fused level on MRI, and as such, CT and radiographs remain superior to MRI for the assessment of hardware and arthrodesis [89]. However, MRI is the most sensitive imaging modality for the assessment of soft tissue abnormalities, including cervical spine soft tissues [1,46]. In patients with prior cervical spine surgery, MRI offers the benefit of detection of adjacent level disease including disc herniations and nerve impingement [79]. In the absence of "red flag" symptoms, the addition of IV contrast is not routinely used in cases of anterior approach surgeries because the epidural space is rarely transgressed. Evidence for the addition of IV contrast for posterior approach cervical spine surgeries is lacking, and the majority of clinical use is derived from lumbar spine data, which suggests a benefit of IV contrast for discriminating recurrent/residual disc disease (potentially surgical) from scar tissue [90,91]. Finally, it is worth noting that emerging MRI techniques for metal reduction are likely to increase the use of MRI in postoperative cervical or neck pain [79].

Variant 3: Adult. Prior cervical spine surgery. Acute or increasing mechanical cervical pain or radiculopathy. No trauma or "red flags." Initial imaging.
M. MRI cervical spine without IV contrast

Hardware metal artifact limits assessment of the fused level on MRI, and as such, CT and radiographs remain superior to MRI for assessment of hardware and arthrodesis [89]. However, MRI is the most sensitive imaging modality for the assessment of soft tissue abnormalities, including cervical spine soft tissues [1,46]. In patients with prior cervical spine surgery, MRI offers

the benefit of detection of adjacent level disease including disc herniations and nerve impingement [79]. The addition of IV contrast is not routinely used in cases of anterior approach surgeries because the epidural space is rarely transgressed. Finally, it is worth noting that emerging MRI techniques for metal reduction are likely to increase the use of MRI in postoperative cervical or neck pain [79].

Variant 3: Adult. Prior cervical spine surgery. Acute or increasing mechanical cervical pain or radiculopathy. No trauma or "red flags." Initial imaging.
N. Radiographic myelography cervical spine

CT myelography has supplanted radiographic myelography in this clinical scenario. Radiographic myelography is not useful as a first-line imaging modality for this clinical scenario.

Variant 3: Adult. Prior cervical spine surgery. Acute or increasing mechanical cervical pain or radiculopathy. No trauma or "red flags." Initial imaging.
O. Radiography cervical spine

Radiographs remain a mainstream in the assessment of postoperative spine given its ability to assess hardware, implant loosening, implant migration, and spine alignment and ability to incorporate weightbearing views [73,79]. The addition of dynamic flexion and extension views improves the assessment of solid fusion and ability to detect instrument instability [79,85]. However, radiographs are limited in the assessment of soft tissue and nerve impingement [92].

Variant 3: Adult. Prior cervical spine surgery. Acute or increasing mechanical cervical pain or radiculopathy. No trauma or "red flags." Initial imaging.
P. Radiography cervical spine flexion extension lateral views

Radiographs remain a mainstream in the assessment of postoperative spine given its ability to assess hardware, implant loosening, implant migration, and spine alignment and ability to incorporate weightbearing views [73,79]. The addition of dynamic flexion and extension views improves the assessment of solid fusion and ability to detect instrument instability [79,85]. However, radiographs are limited in the assessment of soft tissue and nerve impingement [92].

Variant 4: Adult. Suspected or known infection with acute or increasing cervical pain or radiculopathy. No trauma. Initial imaging.

Spinal infections represent a spectrum of disease, potentially involving the vertebral bodies, facet joints, disc space, surrounding soft tissue, epidural space, meninges, and spinal cord [93]. Vertebral osteomyelitis constitutes 1% to 5% of osteomyelitis [93,94], with an estimated annual incidence of 2.4 cases per 100,000 [95]. Cervical spine osteomyelitis constitutes 3% to 6% of all cases of vertebral osteomyelitis [96]. Over the last 2 decades, the incidence of spinal infection has grown with an increase in the elderly population, immunosuppression/immunocompromised patients, IV drug use, health care–associated infections, and spinal instrumentations [95,97]. Additional risk factors include diabetes, long-term steroid use, liver failure, and renal failure [95]. The combination of these risk factors with cervical or neck pain, fever, and abnormal labs including elevated ESR and CRP should raise a concern for cervical spine infection [95,98]. Potential etiologies include hematogenous spread (distant infectious site or surgery), direct inoculation (frequently iatrogenic), or contiguous spread of infection from adjacent infected tissue [99]. The presence of clinical signs or symptoms suggesting meningitis or anterior neck infection should be managed based on clinical guidelines separate from this review of neck pain. Imaging of patients with myelopathy related to suspected spinal infection should be guided by the separate ACR Appropriateness Criteria® topic on "Myelopathy" [12].

Variant 4: Adult. Suspected or known infection with acute or increasing cervical pain or radiculopathy. No trauma. Initial imaging.
A. Bone scan whole body with SPECT or SPECT/CT cervical spine

Three-phase Tc-99m methylene diophosphate (MDP) scintigraphy is sensitive (90%) but is not specific (78%) [100]. Common false-positive abnormalities affecting specificity include degenerative disease, hardware, and fracture [101,102].

Variant 4: Adult. Suspected or known infection with acute or increasing cervical pain or radiculopathy. No trauma. Initial imaging.
B. CT cervical spine with IV contrast

CT is superior for the detection of early bone changes relative to radiographs, with nearly half of the patients demonstrating abnormalities visualized on CT in the first 2 weeks of infection [103]. Imaging abnormalities detected on CT include osteolysis, bone erosions, endplate irregularities, soft tissue swelling, and obliteration of surrounding fat planes [94,103]. CT is the best technique for the detection of spinal canal bony sequestrum [103]. The addition of IV contrast allows for the detection of peripherally enhancing adjacent collections [103]. Contrast can also aid in the detection of epidural collections and mass effect on the opacified venous plexus and can aid in the assessment of thecal sac compression [94,103]. CT with IV contrast is complementary to MRI [97].

Variant 4: Adult. Suspected or known infection with acute or increasing cervical pain or radiculopathy. No trauma. Initial imaging.
C. CT cervical spine without and with IV contrast

There is no relevant literature to support the use of CT cervical spine without and with IV contrast in the initial imaging of suspected or known infection with acute or increasing cervical pain or radiculopathy.

Variant 4: Adult. Suspected or known infection with acute or increasing cervical pain or radiculopathy. No trauma. Initial imaging.
D. CT cervical spine without IV contrast

CT is superior for the detection of early bone changes relative to radiographs, with nearly half of the patients demonstrating abnormalities visualized on CT in the first 2 weeks of infection [103]. Imaging abnormalities detected on CT include osteolysis, bone erosions, endplate irregularities, soft tissue swelling, and obliteration of surrounding fat planes [94,103]. CT is the best technique for detection of spinal canal bony sequestrum [103]. The addition of IV contrast allows for the detection of peripherally enhancing adjacent collections [103]. Contrast can also aid in the detection of epidural collections and mass effect on the opacified venous plexus and can aid in the assessment of thecal sac compression [94,103].

Variant 4: Adult. Suspected or known infection with acute or increasing cervical pain or radiculopathy. No trauma. Initial imaging.
E. CT myelography cervical spine

The usefulness of CT myelography has significantly decreased with the advent of MRI [64,65]. CT myelography offers similar advantages to CT in the assessment of osseous structures. CT myelography also offers an excellent alternative to MRI in claustrophobic patients [66]. The literature did not identify any literature regarding the use of CT myelogram as a first-line imaging modality in this clinical scenario. However, CT myelogram offers an excellent alternative to MRI in assessing the spinal canal and neural foramina in infection when MR images are nondiagnostic secondary to extensive hardware artifact [65,66].

Variant 4: Adult. Suspected or known infection with acute or increasing cervical pain or radiculopathy. No trauma. Initial imaging.
F. CTA neck with IV contrast

The literature search did not identify any studies regarding the use of CTA neck in the evaluation of this clinical scenario.

Variant 4: Adult. Suspected or known infection with acute or increasing cervical pain or radiculopathy. No trauma. Initial imaging.
G. Discography cervical spine

The literature search did not identify any studies regarding the use of discography in the evaluation of this clinical scenario.

Variant 4: Adult. Suspected or known infection with acute or increasing cervical pain or radiculopathy. No trauma. Initial imaging.
H. FDG-PET/CT skull base to mid-thigh

PET using the tracer fluorine-18-2-fluoro-2-deoxy-D-glucose (FDG)/CT is the scintigraphic procedure of choice for spinal infection. FDG-PET/CT has the advantage of higher resolution, faster examination, and lower uptake in degenerative disease [100,102]. In a study of 32 patients with vertebral osteomyelitis, FDG-PET/CT sensitivity, specificity, positive predicative value, and negative predicative value in diagnosing vertebral osteomyelitis were 100%, 83.3%, 90.9%, and 100%, respectively [104]. FDG-PET/CT may be the modality of choice in cases of low-grade spinal infection [105].

Variant 4: Adult. Suspected or known infection with acute or increasing cervical pain or radiculopathy. No trauma. Initial imaging.
I. Gallium scan whole body

Several factors increase the uptake of Gallium-67 at site of infection including vascular membrane permeability and increase blood flow [102]. The combination of Gallium-67 with SPECT or bone scintigraphy increases its sensitivity and specificity [101,106,107].

Variant 4: Adult. Suspected or known infection with acute or increasing cervical pain or radiculopathy. No trauma. Initial imaging.
J. MRA neck with IV contrast

The literature search did not identify any studies regarding the use of MRA neck with IV contrast in the evaluation of this clinical scenario.

Variant 4: Adult. Suspected or known infection with acute or increasing cervical pain or radiculopathy. No trauma. Initial imaging.
K. MRA neck without and with IV contrast

The literature search did not identify any studies regarding the use of MRA neck without and with IV contrast in the evaluation of this clinical scenario.

Variant 4: Adult. Suspected or known infection with acute or increasing cervical pain or radiculopathy. No trauma. Initial imaging.
L. MRA neck without IV contrast

The literature search did not identify any studies regarding the use of MRA neck without IV contrast in the evaluation of this clinical scenario.

Variant 4: Adult. Suspected or known infection with acute or increasing cervical pain or radiculopathy. No trauma. Initial imaging.

M. MRI cervical spine with IV contrast

MRI cervical spine with IV contrast is not useful as a separate examination without the precontrast sequences in this clinical scenario.

Variant 4: Adult. Suspected or known infection with acute or increasing cervical pain or radiculopathy. No trauma. Initial imaging.
N. MRI cervical spine without and with IV contrast

MRI of the spine is the imaging modality of choice for the assessment of suspected spinal infection [93,106]. MRI has a reported sensitivity of 96%, a specificity of 93%, and an accuracy of 94% [100]. MRI offers excellent sensitivity for the detection of paraspinal and epidural inflammation, disk signal abnormality, and end plate abnormality [108]. The addition of IV contrast might not be needed for the detection of bone marrow edema [109]; however, the addition of IV contrast improves the detection and characterization of epidural abscess, meningitis, and myelitis [109,110]. Diffusion-weighted imaging sequence acquisition can further aid in the diagnosis of spinal abscesses, better characterize fluid collections, and aid in distinguishing end plate Modic type 1 changes from infection [111,112].

Variant 4: Adult. Suspected or known infection with acute or increasing cervical pain or radiculopathy. No trauma. Initial imaging.
O. MRI cervical spine without IV contrast

MRI of the spine is the imaging modality of choice for the assessment of suspected spinal infection [93,106]. MRI has a reported sensitivity of 96%, a specificity of 93%, and an accuracy of 94% [100]. MRI offers excellent sensitivity for the detection of paraspinal and epidural inflammation, disk signal abnormality, and end plate abnormality [108]. Diffusion-weighted imaging sequence acquisition can further aid in the diagnosis of spinal abscesses, better characterize fluid collections, and aid in distinguishing end plate Modic type 1 changes from infection [111,112].

Variant 4: Adult. Suspected or known infection with acute or increasing cervical pain or radiculopathy. No trauma. Initial imaging.
P. Radiographic myelography cervical spine

CT myelography has supplanted radiographic myelography in this clinical scenario. Radiographic myelography is not useful as a first-line imaging modality for this clinical scenario.

Variant 4: Adult. Suspected or known infection with acute or increasing cervical pain or radiculopathy. No trauma. Initial imaging.
Q. Radiography cervical spine

Radiographs are frequently the first imaging modality obtained for the assessment of spinal infection [99,103]. However, radiographs have a low specificity and are frequently normal in the early disease process within the first 2 to 3 weeks [100,103] because 30% to 40% of bone destruction is needed before the detection of imaging findings on radiographs [94,99,113]. Therefore, negative radiographs in the clinical scenario of suspicion for cervical or neck infection should not be considered a comprehensive imaging workup.

Variant 4: Adult. Suspected or known infection with acute or increasing cervical pain or radiculopathy. No trauma. Initial imaging.
R. Radiography cervical spine flexion extension lateral views

Radiographs are frequently the first imaging modality obtained for assessment of spinal infection [99,103]. However, radiographs have a low specificity and are frequently normal in the early disease process within the first 2 to 3 weeks [100,103] because 30% to 40% of bone destruction is needed

before the detection of imaging findings on radiographs [94,99,113]. Therefore, negative radiographs in the clinical scenario of suspicion for cervical or neck infection should not be considered a comprehensive imaging workup.

Variant 4: Adult. Suspected or known infection with acute or increasing cervical pain or radiculopathy. No trauma. Initial imaging.
S. WBC scan whole body

Indium-labeled leucocytes scan has a low sensitivity and a false-negative rate of 40%, with spondylodiscitis often appearing as a photopenic region [114]. Another disadvantage is the interval between injection and imaging lasting potentially up to 30 hours [115].

Variant 5: Adult. Diagnosis of malignancy with acute or increasing cervical pain or radiculopathy. No trauma. Initial imaging.

Primary spine tumors are uncommon, with cervical spine being the most commonly affected site [116]. Spine is the third most common site for distant metastatic disease and the most common site of osseous metastases [117,118]. Spinal metastasis is common in patients with distant metastatic disease, with 50% to 70% of such patients having spinal metastasis [119]. Furthermore, 70% of patients with malignancy demonstrate spinal metastasis at autopsy [120]. Spinal metastasis contributes to mortality and morbidity including pathological fractures, hypercalcemia, spinal cord compression, and disability. In addition, spinal metastasis results in significant economic burden on the patient, society, and health care system, with the national cost of metastatic bone disease estimated to represent 17%, $12.6 billion, in total direct medical cost estimated by the National Institutes of Health in 2007 [121]. Spinal metastasis is primarily diagnosed on imaging. The imaging modality of choice is influenced by the tumor histology and clinical concern for complications such as pathological fracture, epidural disease, nerve root impingement, and spinal cord compression.

Variant 5: Adult. Diagnosis of malignancy with acute or increasing cervical pain or radiculopathy. No trauma. Initial imaging.
A. Bone scan whole body with SPECT or SPECT/CT cervical spine

Bone scintigraphy is the most common imaging modality for the detection of spinal metastasis [122]. Bone scintigraphy has a sensitivity of 78% and a low specificity of 48%. [123]. Factors contributing to low specificity include uptake in degenerative disease, fractures, and benign lesions [123,124]. The addition of SPECT and combination of SPECT/CT helps improve resolution and anatomical localization [123].

Variant 5: Adult. Diagnosis of malignancy with acute or increasing cervical pain or radiculopathy. No trauma. Initial imaging.
B. CT cervical spine with IV contrast

CT has a higher sensitivity for the detection of bone metastasis in comparison with radiographs and is better suited for complex overlapping anatomical structures [123,125]. CT offers the ability for bone metastasis assessment, while simultaneously staging/restaging other organs [123]. CT has a pooled sensitivity and specificity of 73% and 94%, respectively [126]. CT sensitivity is high for the detection of osteolytic and osteoblastic lesions in cortical bone [125]. The addition of IV contrast may aid in the assessment of paraspinal or epidural tumor extension [127]. However, CT sensitivity is low for the detection of marrow-restricted metastasis, unless extensive, limiting it as a screening tool for spinal metastasis [125].

Variant 5: Adult. Diagnosis of malignancy with acute or increasing cervical pain or

radiculopathy. No trauma. Initial imaging.
C. CT cervical spine without and with IV contrast

There is no relevant literature to support the use of CT cervical spine without and with IV contrast in the initial imaging of malignancy with acute or increasing cervical pain or radiculopathy.

Variant 5: Adult. Diagnosis of malignancy with acute or increasing cervical pain or radiculopathy. No trauma. Initial imaging.
D. CT cervical spine without IV contrast

CT has a higher sensitivity for the detection of bone metastasis in comparison with radiographs and is better suited for complex overlapping anatomical structures [123,125]. CT offers the ability for bone metastasis assessment, while simultaneously staging/restaging other organs [123]. CT has a pooled sensitivity and specificity of 73% and 94%, respectively [126]. CT sensitivity is high for the detection of osteolytic and osteoblastic lesions in cortical bone [125]. However, CT sensitivity is low for the detection of marrow-restricted metastasis, unless extensive, limiting it as a screening tool for spinal metastasis [125].

Variant 5: Adult. Diagnosis of malignancy with acute or increasing cervical pain or radiculopathy. No trauma. Initial imaging.
E. CT myelography cervical spine

The usefulness of CT myelography has significantly decreased with the advent of MRI [64,65]. CT myelography offers similar advantages to CT in the assessment of osseous structures. CT myelography also offers an excellent alternative to MRI in claustrophobic patients [66]. The literature search did not identify any literature regarding the use of CT myelogram as a first-line imaging modality in this clinical scenario.

Variant 5: Adult. Diagnosis of malignancy with acute or increasing cervical pain or radiculopathy. No trauma. Initial imaging.
F. CTA neck with IV contrast

The literature search did not identify any studies regarding the use of CTA neck in the evaluation of this clinical scenario. However, CTA may be indicated if there is concern of spread of tumor to the adjacent vessels, in particular the vertebral arteries, or if there are clinical symptoms concerning for vascular involvement.

Variant 5: Adult. Diagnosis of malignancy with acute or increasing cervical pain or radiculopathy. No trauma. Initial imaging.
G. Discography cervical spine

The literature search did not identify any studies regarding the use of discography in the evaluation of this clinical scenario.

Variant 5: Adult. Diagnosis of malignancy with acute or increasing cervical pain or radiculopathy. No trauma. Initial imaging.
H. FDG-PET/CT whole body

FDG-PET/CT is a primary imaging modality for initial staging and restaging of patients with cancer. PET/CT offers the advantage of simultaneous detection of skeletal and extraskeletal disease and the assessment of the entire spine [128]. FDG-PET/CT is superior to bone scintigraphy in the detection of lytic metastases [129]. A meta-analysis assessing FDG-PET/CT in the diagnosis of bone metastases showed a per-patient sensitivity of 89.7% and specificity of 96.8% [126]. However, it is worth noting that the sensitivity and specificity of FDG-PET/CT in the diagnosis of bone metastases varies with different histologies (eg, prostate cancer and neuroendocrine tumors) [130]. Discussion

of appropriate PET radiotracers for specific malignancies is beyond the scope of this document, and the reader is advised to consult with a radiologist for appropriate radiotracer as indicated. Lastly, PET resolution limits its ability to assess epidural disease, spinal cord involvement/compression, and neural foramina involvement.

Variant 5: Adult. Diagnosis of malignancy with acute or increasing cervical pain or radiculopathy. No trauma. Initial imaging.
I. FDG-PET/MRI skull base to mid-thigh

The recent use of fused FDG and MRI has shown promising early results in oncological and nononcological disease [131]. Early studies show comparable sensitivity for the detection of focal bone lesions for FDG-PET/MRI and FDG-PET/CT [132]. Whole body FDG-PET/MRI may have a better detection rate and delineation of bone metastasis relative to FDG-PET/CT [133], whereas FDG-PET/CT may have a higher diagnostic confidence of benign bone lesions [133]. Currently, there are limited data for the use of FDG-PET/MRI as a first-line imaging modality for the assessment of cervical or neck pain in patients with known malignancy.

Variant 5: Adult. Diagnosis of malignancy with acute or increasing cervical pain or radiculopathy. No trauma. Initial imaging.
J. FDG-PET/MRI whole body

The recent use of fused FDG and MRI has shown promising early results in oncological and nononcological disease [131]. Early studies show comparable sensitivity for detection of focal bone lesions for FDG-PET/MRI and FDG-PET/CT [132]. Whole body FDG-PET/MRI may have a better detection rate and delineation of bone metastasis relative to FDG-PET/CT [133], whereas FDG-PET/CT may have a higher diagnostic confidence of benign bone lesions [133]. Currently, there are limited data for the use of FDG-PET/MRI as a first-line imaging modality for the assessment of cervical or neck pain in patients with known malignancy.

Variant 5: Adult. Diagnosis of malignancy with acute or increasing cervical pain or radiculopathy. No trauma. Initial imaging.
K. Fluoride PET/CT whole body

F-18 sodium fluoride (NaF) is a bone-specific agent that has benefited from the development of PET/CT [128]. F-18 NaF shares a similar mechanism of action with Tc-99m but has more favorable pharmacokinetics, osseous uptake, and blood clearance [134]. However, like Tc-99m, NaF frequently is positive in nonmalignant cases [128]. In a study of 212 patients with morbid obesity, F-18 NaF PET/CT was noted to maintain its diagnostic accuracy, suggesting it as a primary imaging modality for bone pathology in this patient population [135]. However, currently there is no evidence supporting the use of F-18 NaF PET/CT as a first-line modality for assessing patients with cervical or neck pain with history of malignancy.

Variant 5: Adult. Diagnosis of malignancy with acute or increasing cervical pain or radiculopathy. No trauma. Initial imaging.
L. MRA neck with IV contrast

The literature search did not identify any studies regarding the use of MRA neck with IV contrast in the evaluation of this clinical scenario. However, MRA may be indicated if there is concern of spread of malignancy to the adjacent vessels, in particular the vertebral arteries, or if there are clinical symptoms concerning vascular involvement.

Variant 5: Adult. Diagnosis of malignancy with acute or increasing cervical pain or radiculopathy. No trauma. Initial imaging.

M. MRA neck without and with IV contrast

The literature search did not identify any studies regarding the use of MRA neck without and with IV contrast in the evaluation of this clinical scenario. However, MRA may be indicated if there is concern of spread of malignancy to the adjacent vessels, in particular the vertebral arteries, or if there are clinical symptoms concerning vascular involvement.

Variant 5: Adult. Diagnosis of malignancy with acute or increasing cervical pain or radiculopathy. No trauma. Initial imaging.
N. MRA neck without IV contrast

The literature search did not identify any studies regarding the use of MRA neck without IV contrast in the evaluation of this clinical scenario. However, MRA may be indicated if there is concern of spread of malignancy to the adjacent vessels, in particular the vertebral arteries, or if there are clinical symptoms concerning vascular involvement.

Variant 5: Adult. Diagnosis of malignancy with acute or increasing cervical pain or radiculopathy. No trauma. Initial imaging.
O. MRI cervical spine with IV contrast

MRI cervical spine with IV contrast is not useful as a separate examination without the precontrast sequences in this clinical scenario.

Variant 5: Adult. Diagnosis of malignancy with acute or increasing cervical pain or radiculopathy. No trauma. Initial imaging.
P. MRI cervical spine without and with IV contrast

MRI is the imaging modality of choice for assessment of spinal metastasis. A meta-analysis of imaging diagnosis of bone metastasis demonstrated an MR pooled sensitivity and specificity, per patient, of 90.6% and 95.4%, respectively [126]. This was comparable to FDG-PET and superior to bone scan [126]. MRI is more sensitive than CT for the detection of early marrow changes and can detect very early changes in the bone marrow space [123,133]. MRI is the most sensitive imaging modality for the assessment of soft tissue abnormalities, including cervical spine soft tissues [1,46]. This makes MRI the modality of choice for the assessment of tumor extension into surrounding soft tissues including prevertebral soft tissue, epidural space, and neural foramina [123,136]. MRI allows for better assessment of spinal cord compression and spinal cord signal abnormality [123]. The addition of IV contrast can further aid in assessment of soft tissue extension including epidural disease, leptomeningeal involvement, and intramedullary involvement [119].

Variant 5: Adult. Diagnosis of malignancy with acute or increasing cervical pain or radiculopathy. No trauma. Initial imaging.
Q. MRI cervical spine without IV contrast

MRI is the imaging modality of choice for assessment of spinal metastasis. A meta-analysis of imaging diagnosis of bone metastasis demonstrated an MR pooled sensitivity and specificity, per patient, of 90.6% and 95.4%, respectively [126]. This was comparable to FDG-PET and superior to bone scan [126]. MRI is more sensitive than CT for the detection of early marrow changes and can detect very early changes in the bone marrow space [123,133]. MRI is the most sensitive imaging modality for the assessment of soft tissue abnormalities, including cervical spine soft tissues [1,46]. This makes MRI the modality of choice for the assessment of tumor extension into surrounding soft tissues including prevertebral soft tissue, epidural space, and neural foramina [123,136]. MRI allows for better assessment of spinal cord compression and spinal cord signal abnormality [123].

Variant 5: Adult. Diagnosis of malignancy with acute or increasing cervical pain or

radiculopathy. No trauma. Initial imaging.
R. Radiographic myelography cervical spine

CT myelography has supplanted radiographic myelography in this clinical scenario. Radiographic myelography is not useful as a first-line imaging modality for this clinical scenario.

Variant 5: Adult. Diagnosis of malignancy with acute or increasing cervical pain or radiculopathy. No trauma. Initial imaging.
S. Radiography cervical spine

Radiographs are frequently the first study obtained in patients with malignancy and spinal pain or in patients with abnormal bone scan requiring further assessment [123,136]. However, radiographs are insensitive for the detection of early disease, and 50% to 70% of bone destruction is needed before reliable detection of osteolytic changes [123,137]. Furthermore, lesions <1 cm are frequently not apparent on radiographs. Therefore, negative radiographs in the setting of malignancy and cervical or neck pain should not be considered sufficient imaging for metastases exclusion.

Variant 5: Adult. Diagnosis of malignancy with acute or increasing cervical pain or radiculopathy. No trauma. Initial imaging.
T. Radiography cervical spine flexion extension lateral views

Radiographs are frequently the first study obtained in patients with malignancy and spinal pain or in patients with abnormal bone scan requiring further assessment [123,136]. However, radiographs are insensitive for the detection of early disease, and 50% to 70% of bone destruction is needed before reliable detection of osteolytic changes [123,137]. Furthermore, lesions <1 cm are frequently not apparent on radiographs. Therefore, negative radiographs in the setting of malignancy and cervical or neck pain should not be considered sufficient imaging for metastases exclusion.

Variant 6: Adult. Suspected cervicogenic headache. No neurologic deficit. Initial imaging.

The International Headache Society defines cervicogenic headache as a headache secondary to disorders of the cervical spine, and its elements including bony, disc, and/or soft tissue elements [138]. Cervicogenic headache is typically accompanied by cervical or neck pain [138]. The estimated prevalence of cervicogenic headache is 4% in the general population and up to 20% in patients with chronic headaches [139]. Cervicogenic headache presents as pain over the head region secondary to nociceptive sources from the upper cervical spine including cervical muscles, disc space, facet joints, and nerve roots [140]. Diagnosis of cervicogenic headache remains challenging given heterogenous definitions in clinical trials, overlapping symptoms with other headache disorders, lack of definitive radiological findings, and high prevalence of abnormal imaging findings in asymptomatic patients [138-142]. One important diagnostic technique that has shown promise is percutaneous interventions. Percutaneous interventions offer the advantage of diagnosis confirmation of the suspected culprit and provide a treatment option for patients with cervicogenic headache. Recent literature has focused on the assessment of outcomes of ultrasound and CT for blockage and ablation of suspected trigger points/culprits in the cervical spine including ablation of intravertebral discs [139,143-146]. It is important to assess other headache etiologies, in particular vascular dissection, in the setting of unilateral headache and neck pain. These etiologies are assessed in the ACR Appropriateness Criteria® topic on "Headache" [14].

Variant 6: Adult. Suspected cervicogenic headache. No neurologic deficit. Initial imaging.
A. Bone scan whole body with SPECT or SPECT/CT cervical spine

There is currently no evidence to support the use of nuclear medicine studies as the initial imaging modalities for cervicogenic headache. Bone scan lacks both a sensitivity and spatial resolution to detect pathology related to nerve root compression and/or irritation [41]. Combined SPECT/CT overcomes spatial resolution limitation [41]. However, SPECT cannot assess disc herniation or nerve root impingement [81].

Variant 6: Adult. Suspected cervicogenic headache. No neurologic deficit. Initial imaging. B. CT cervical spine with IV contrast

There is no evidence that imaging is diagnostic for cervicogenic headache given the lack of definitive imaging diagnostic criteria and high frequency of abnormal imaging findings in asymptomatic patients [138,140,142].

Variant 6: Adult. Suspected cervicogenic headache. No neurologic deficit. Initial imaging. C. CT cervical spine without and with IV contrast

There is no evidence that imaging is diagnostic for cervicogenic headache given the lack of definitive imaging diagnostic criteria and high frequency of abnormal imaging findings in asymptomatic patients [138,140,142].

Variant 6: Adult. Suspected cervicogenic headache. No neurologic deficit. Initial imaging. D. CT cervical spine without IV contrast

There is no evidence that imaging is diagnostic for cervicogenic headache given the lack of definitive imaging diagnostic criteria and high frequency of abnormal imaging findings in asymptomatic patients [138,140,142].

Variant 6: Adult. Suspected cervicogenic headache. No neurologic deficit. Initial imaging. E. CT myelography cervical spine

In the absence of radiographic abnormalities or neurological symptoms, CT myelography is not a useful first-line imaging test.

Variant 6: Adult. Suspected cervicogenic headache. No neurologic deficit. Initial imaging. F. CTA neck with IV contrast

The literature search did not identify any studies regarding the use of CTA neck in the evaluation of this clinical scenario. However, if there is concern for cervical arterial dissection, CTA may be indicated.

Variant 6: Adult. Suspected cervicogenic headache. No neurologic deficit. Initial imaging. G. MRA neck with IV contrast

The literature search did not identify any studies regarding the use of MRA neck with IV contrast in the evaluation of this clinical scenario. However, if there is concern for cervical arterial dissection, MRA may be indicated.

Variant 6: Adult. Suspected cervicogenic headache. No neurologic deficit. Initial imaging. H. MRA neck without and with IV contrast

The literature search did not identify any studies regarding the use of MRA neck without and with IV contrast in the evaluation of this clinical scenario. However, if there is concern for cervical arterial dissection, MRA may be indicated.

Variant 6: Adult. Suspected cervicogenic headache. No neurologic deficit. Initial imaging. I. MRA neck without IV contrast

The literature search did not identify any studies regarding the use of MRA neck without IV

contrast in the evaluation of this clinical scenario. However, if there is concern for cervical arterial dissection, MRA may be indicated.

Variant 6: Adult. Suspected cervicogenic headache. No neurologic deficit. Initial imaging. J. MRI cervical spine with IV contrast

MRI cervical spine with IV contrast is not useful as a separate examination without the precontrast sequences in this clinical scenario.

Variant 6: Adult. Suspected cervicogenic headache. No neurologic deficit. Initial imaging. K. MRI cervical spine without and with IV contrast

There is no evidence that imaging is diagnostic for cervicogenic headache given the lack of definitive imaging diagnostic criteria and high frequency of abnormal imaging findings in asymptomatic patients [138,140,142]. Coskun et al [141] compared the conventional MRI findings of 22 patients with cervicogenic headache with those of 20 controls and found no significant difference in imaging features. Advanced MRI techniques such as diffusion tensor imaging can offer advantages in the assessment of cervical nerves, which can aid in diagnosis and potentially treatment [147]. Although these MRI techniques offer great potential, they remain experimental at this point, and larger population studies are required before adoption. There is no relevant literature to support the use of MRI cervical spine without and with IV contrast in the initial imaging of cervicogenic headache.

Variant 6: Adult. Suspected cervicogenic headache. No neurologic deficit. Initial imaging. L. MRI cervical spine without IV contrast

There is no evidence that imaging is diagnostic for cervicogenic headache given the lack of definitive imaging diagnostic criteria and high frequency of abnormal imaging findings in asymptomatic patients [138,140,142]. Coskun et al [141] compared the conventional MRI findings of 22 patients with cervicogenic headache with those of 20 controls and found no significant difference in imaging features. Advanced MRI techniques such as diffusion tensor imaging can offer advantages in assessment of cervical nerves, which can aid in diagnosis and potentially treatment [147]. Although these MRI techniques offer great potential, they remain experimental at this point, and larger population studies are required before adoption.

Variant 6: Adult. Suspected cervicogenic headache. No neurologic deficit. Initial imaging. M. Radiographic myelography cervical spine

In the absence of radiographic abnormalities or neurological symptoms, radiographic myelography is not an appropriate first-line imaging test.

Variant 6: Adult. Suspected cervicogenic headache. No neurologic deficit. Initial imaging. N. Radiography cervical spine

There is no evidence that imaging is diagnostic for cervicogenic headache given the lack of definitive imaging diagnostic criteria and high frequency of abnormal imaging findings in asymptomatic patients [138,140,142].

Variant 6: Adult. Suspected cervicogenic headache. No neurologic deficit. Initial imaging. O. Radiography cervical spine flexion extension lateral views

There is no evidence that imaging is diagnostic for cervicogenic headache given the lack of definitive imaging diagnostic criteria and high frequency of abnormal imaging findings in asymptomatic patients [138,140,142].

Variant 7: Adult. Chronic cervical pain without radiculopathy. No trauma or "red flags."

Initial imaging.

Neck pain is 1 of the top 5 leading causes of global years lost to disability [1-4]. Neck pain is common, with an estimated 1 year mean prevalence of 25% [148]. Although a good proportion of chronic neck pain resolves spontaneously, approximately 30% to 50% of patients will develop chronic neck pain symptoms or disability lasting more than a year [1,149].

Variant 7: Adult. Chronic cervical pain without radiculopathy. No trauma or "red flags." Initial imaging.

A. Bone scan whole body with SPECT or SPECT/CT cervical spine

There is currently no evidence to support the use of nuclear medicine studies as the initial imaging modalities for chronic cervical or neck pain. Bone scan offers a very sensitive modality for the detection of spinal pathology and often detects functional and metabolic changes before anatomical changes noted on radiographs, CT, and MRI [41]. However, bone scan lacks both the sensitivity and spatial resolution [41]. Combined SPECT/CT overcomes spatial resolution limitation [41]. Furthermore, in patients with chronic neck or cervical pain with suspected underlying fact pathology and equivocal MR and CT imaging findings, SPECT and combined SPECT/CT have shown promising results in localizing facet pain and potentially help in guiding treatment [150,151]

Variant 7: Adult. Chronic cervical pain without radiculopathy. No trauma or "red flags." Initial imaging.

B. CT cervical spine with IV contrast

CT is not currently recommended as a first-line examination for chronic neck pain in the absence of red flags or neurological symptoms.

Variant 7: Adult. Chronic cervical pain without radiculopathy. No trauma or "red flags." Initial imaging.

C. CT cervical spine without and with IV contrast

CT is not currently recommended as a first-line examination for chronic neck pain in the absence of red flags or neurological symptoms.

Variant 7: Adult. Chronic cervical pain without radiculopathy. No trauma or "red flags." Initial imaging.

D. CT cervical spine without IV contrast

CT is not currently recommended as a first-line examination for chronic neck pain in the absence of red flags or neurological symptoms.

Variant 7: Adult. Chronic cervical pain without radiculopathy. No trauma or "red flags." Initial imaging.

E. CT myelography cervical spine

CT myelography is not useful for chronic neck pain in the absence of radicular or myelopathic symptoms.

Variant 7: Adult. Chronic cervical pain without radiculopathy. No trauma or "red flags." Initial imaging.

F. CTA neck with IV contrast

The literature search did not identify any studies regarding the use of CTA neck in the evaluation of this clinical scenario.

Variant 7: Adult. Chronic cervical pain without radiculopathy. No trauma or "red flags." Initial imaging.

G. Discography cervical spine

The literature search did not identify any studies regarding the use of discography as a first-line test in the evaluation of this clinical scenario.

Variant 7: Adult. Chronic cervical pain without radiculopathy. No trauma or "red flags." Initial imaging.
H. MRA neck with IV contrast

The literature search did not identify any studies regarding the use of MRA neck with IV contrast in the evaluation of this clinical scenario.

Variant 7: Adult. Chronic cervical pain without radiculopathy. No trauma or "red flags." Initial imaging.
I. MRA neck without and with IV contrast

The literature search did not identify any studies regarding the use of MRA neck without and with IV contrast in the evaluation of this clinical scenario.

Variant 7: Adult. Chronic cervical pain without radiculopathy. No trauma or "red flags." Initial imaging.
J. MRA neck without IV contrast

The literature search did not identify any studies regarding the use of MRA neck without IV contrast in the evaluation of this clinical scenario.

Variant 7: Adult. Chronic cervical pain without radiculopathy. No trauma or "red flags." Initial imaging.
K. MRI cervical spine with IV contrast

MRI cervical spine with IV contrast is not useful as a separate examination without the precontrast sequences in this clinical scenario.

Variant 7: Adult. Chronic cervical pain without radiculopathy. No trauma or "red flags." Initial imaging.
L. MRI cervical spine without and with IV contrast

MRI is the most sensitive imaging modality for the assessment of soft tissue abnormalities, including cervical spine soft tissues [1,46]. However, a high rate of detected abnormalities is noted in asymptomatic patients [1,47,60,148]. Therefore, in the absence of "red flag" or radiculopathy symptoms, MRI is not considered a first-line imaging modality in this clinical scenario. The addition of contrast in this scenario is not considered useful if there is no concern for "red flag" symptoms.

Variant 7: Adult. Chronic cervical pain without radiculopathy. No trauma or "red flags." Initial imaging.
M. MRI cervical spine without IV contrast

MRI is the most sensitive imaging modality for the assessment of soft tissue abnormalities, including cervical spine soft tissues [1,46]. However, a high rate of detected abnormalities is noted in asymptomatic patients [1,47,60,148]. Therefore, in the absence of "red flag" or radiculopathy symptoms, MRI is not considered a first-line imaging modality in this clinical scenario.

Variant 7: Adult. Chronic cervical pain without radiculopathy. No trauma or "red flags." Initial imaging.
N. Radiographic myelography cervical spine

Radiographic myelography is not a useful first-line imaging modality for chronic neck pain.

Variant 7: Adult. Chronic cervical pain without radiculopathy. No trauma or "red flags." Initial imaging.
O. Radiography cervical spine

Radiographs are frequently ordered as the first imaging modality for the assessment of chronic neck and cervical pain. Spine radiographs are useful in the initial assessment and screening of spondylosis, degenerative disc disease, and malalignment. In a study of 1,581 patients between 18 and 97 years of age, 53.9% of individuals demonstrated disc degenerative changes, with prevalence and severity increasing with age [67]. However, the association of these findings with clinical symptoms remains unclear [67].

Variant 7: Adult. Chronic cervical pain without radiculopathy. No trauma or "red flags." Initial imaging.
P. Radiography cervical spine flexion extension lateral views

Radiographs are frequently ordered as the first imaging modality for the assessment of chronic neck and cervical pain. Spine radiographs are useful in the initial assessment and screening of spondylosis, degenerative disc disease, and malalignment. In a study of 1,581 patients between 18 and 97 years of age, 53.9% of individuals demonstrated disc degenerative changes, with prevalence and severity increasing with age [67]. However, the association of these findings with clinical symptoms remains unclear [67].

Variant 8: Adult. Chronic cervical pain with radiculopathy. No trauma or "red flags." Initial imaging.

Neck pain is common, with an estimated 1-year mean prevalence of 25% [148]. Although a good proportion of chronic neck pain resolves spontaneously, approximately 30% to 50% of patients will develop chronic neck pain symptoms or disability lasting more than a year [1,149]. Cervical radiculopathy is a common cause of chronic neck pain with an estimated annual incidence of 83 per 100,000 persons [51]. Cervical radiculopathy is characterized by upper limb pain or sensorimotor deficit secondary to cervical nerve root impingement and/or irritation [50,52]. It frequently presents as neck and/or upper limb pain with or without varying degrees of sensory or motor deficits [50]. The cervical nerve irritation or compression can be secondary to soft disc (herniated disc), hard disc (spondylarthrosis such as facet or uncovertebral joints), or a combination of both [50,53]. Cervical radiculopathy is frequently self-limiting, with 75% to 90% of patients achieving symptomatic relief with nonoperative conservative therapy [152].

Diagnosis of cervical radiculopathy is achieved by a combination of clinical history, physical examination, and imaging. However, a systemic review assessing the value of physical tests in diagnosis of cervical radiculopathy in comparison with the reference standard of imaging or surgery found limited evidence for the accuracy of physical examinations for the diagnosis of cervical radiculopathy [54]. MRI alone should not be used to diagnose symptomatic cervical radiculopathy and should always be interpreted in combination with the clinical findings, given frequent false-positive and false-negative MRI findings [55].

Variant 8: Adult. Chronic cervical pain with radiculopathy. No trauma or "red flags." Initial imaging.
A. Bone scan whole body with SPECT or SPECT/CT cervical spine

There is currently no evidence to support the use of nuclear medicine studies as the initial imaging modalities for chronic cervical pain with radiculopathy. Bone scan lacks both the sensitivity and spatial resolution to detect pathology related to nerve root compression and/or irritation [41].

Combined SPECT/CT overcomes spatial resolution limitation [41] but has limitations in the assessment of disc herniation and soft tissue nerve roots impingements. However, in patients with chronic neck or cervical pain with suspected underlying fact pathology and equivocal MR and CT imaging findings, SPECT and combined SPECT/CT have shown promising results in localizing facet pain and potentially help in guiding treatment [150,151].

Variant 8: Adult. Chronic cervical pain with radiculopathy. No trauma or "red flags." Initial imaging.

B. CT cervical spine with IV contrast

There is no relevant literature to support the use of CT cervical spine with IV contrast in the initial imaging of chronic cervical pain with radiculopathy.

Variant 8: Adult. Chronic cervical pain with radiculopathy. No trauma or "red flags." Initial imaging.

C. CT cervical spine without and with IV contrast

There is no relevant literature to support the use of CT cervical spine without and with IV contrast in the initial imaging of chronic cervical pain with radiculopathy.

Variant 8: Adult. Chronic cervical pain with radiculopathy. No trauma or "red flags." Initial imaging.

D. CT cervical spine without IV contrast

CT offers superior depiction of the bones relative to radiographs, in particular, potential nerve impinging osseous structures such as osteophytes, uncovertebral joints, and facet joints [42,43]. However, CT is less sensitive for the evaluation of nerve root compression, in particular, in cases of herniated disc relative to MRI [62,63]. The advancement of new CT techniques such as dual-energy CT and photon counting offers promising dose reduction scanning parameters [44,45]. However, currently this has not gained widespread use and has not been extensively studied in the neck or cervical pain population. The addition of contrast does not add significant value in the absence of "red flag" symptoms in this clinical scenario. CT offers a complementary benefit to MRI in a subset of patients with chronic radiculopathy. In the suspected cases of chronic myelopathy or radiculopathy secondary to the ossification of the posterior longitudinal ligament (OPLL), CT offers a superior ability and reproducibility in assessing the subtype of OPLL, extent of disease, and ossification complications such as nerve root and spinal canal compression in comparison with radiographs [153].

Variant 8: Adult. Chronic cervical pain with radiculopathy. No trauma or "red flags." Initial imaging.

E. CT myelography cervical spine

The usefulness of CT myelography has significantly decreased with the advent of MRI, which has supplanted CT myelography as a first-line modality for assessment of cervical radiculopathy [64,65]. CT myelography offers similar advantages to CT in the assessment of osseous structures. Also, CT myelography images are obtained at higher spatial resolution than MRI and offer excellent depiction of the thecal sac and small nerve roots [66]. CT myelography offers a complementary benefit to MRI in a subset of patients with chronic radiculopathy [154]. CT myelography also offers an excellent alternative to MRI in claustrophobic patients [66]. It is important to note that both cervical and lumbar approach myelography procedures for the assessment of cervical degenerative disease have documented risks and patients' adverse events. In a study assessing patients' experience to myelography, 30% of patients reported an unexpected

reaction and 14% had a maximum pain score of 10 during the procedure [154].

Variant 8: Adult. Chronic cervical pain with radiculopathy. No trauma or "red flags." Initial imaging.
F. CTA neck with IV contrast

The literature search did not identify any studies regarding the use of CTA neck in the evaluation of this clinical scenario.

Variant 8: Adult. Chronic cervical pain with radiculopathy. No trauma or "red flags." Initial imaging.
G. Discography cervical spine

The Bone and Joint Decade 2000-2010 Task Force on Neck Pain and Its Associated Disorders concluded there was no evidence to support using cervical provocative discography or anesthetic facet or nerve blocks for the diagnosis of cervical radiculopathy/pain source [40].

Variant 8: Adult. Chronic cervical pain with radiculopathy. No trauma or "red flags." Initial imaging.
H. MRA neck with IV contrast

The literature search did not identify any studies regarding the use of MRA neck with IV contrast in the evaluation of this clinical scenario.

Variant 8: Adult. Chronic cervical pain with radiculopathy. No trauma or "red flags." Initial imaging.
I. MRA neck without and with IV contrast

The literature search did not identify any studies regarding the use of MRA neck without and with IV contrast in the evaluation of this clinical scenario.

Variant 8: Adult. Chronic cervical pain with radiculopathy. No trauma or "red flags." Initial imaging.
J. MRA neck without IV contrast

The literature search did not identify any studies regarding the use of MRA neck without IV contrast in the evaluation of this clinical scenario.

Variant 8: Adult. Chronic cervical pain with radiculopathy. No trauma or "red flags." Initial imaging.
K. MRI cervical spine with IV contrast

MRI cervical spine with IV contrast is not useful as a separate examination without the precontrast sequences in this clinical scenario.

Variant 8: Adult. Chronic cervical pain with radiculopathy. No trauma or "red flags." Initial imaging.
L. MRI cervical spine without and with IV contrast

MRI is the most sensitive imaging modality for the assessment of soft tissue abnormalities, including cervical spine soft tissues [1,46]. In a 1998 retrospective study of 34 patients with clinically diagnosed cervical radiculopathy and subsequent surgery, Brown et al [68] reported that preoperative MRI correctly predicted 88% of the lesions as opposed to 81% for CT myelography, 57% for plain myelography, and 50% for CT. These findings continue to hold true in more recent studies comparing CT myelography and MRI in cervical spine degenerative disorders for the detection of disc abnormality and nerve root compression [69]. However, as noted previously, MRI

demonstrates a frequent rate of false-negative and false-positive findings [55]. Also, MRI is frequently positive in asymptomatic patients, detected abnormalities are not always associated with symptoms severity or outcomes [47,60], and abnormal levels on MRI do not always correspond to abnormal clinical-physical examination levels [70]. In a study of 98 patients with cervical radiculopathy, the agreement between patients' pain drawing and MRI findings for segmental level was poor, and the interclinical agreement was fair to moderate [155,156]. However, the recent development of newer sequences and reconstructions offers promising ability to overcome such limitations by improving the assessment of osseous nerve root compression, improving the visualization of nerve roots, and increasing the correlation with surgical findings [157-160]. There is no relevant literature to support the use of MRI cervical spine contrast in the initial imaging of adult chronic cervical neck pain with radiculopathy.

Variant 8: Adult. Chronic cervical pain with radiculopathy. No trauma or "red flags." Initial imaging.

M. MRI cervical spine without IV contrast

MRI is the most sensitive imaging modality for the assessment of soft tissue abnormalities, including cervical spine soft tissues [1,46]. Also, MRI offers high spatial resolution [67]. Therefore, MRI has become the modality of choice for the assessment of suspected nerve root impingement in patients with chronic cervical radiculopathy [67]. In a 1998 retrospective study of 34 patients with clinically diagnosed cervical radiculopathy and subsequent surgery, Brown et al [68] reported that preoperative MRI correctly predicted 88% of the lesions as opposed to 81% for CT myelography, 57% for plain myelography, and 50% for CT. These findings continue to hold true in more recent studies comparing CT myelography and MRI in cervical spine degenerative disorders for the detection of disc abnormality and nerve root compression [69]. However, as noted previously, MRI demonstrates a frequent rate of false-negative and false-positive findings [55]. Also, MRI is frequently positive in asymptomatic patients, detected abnormalities are not always associated with symptoms severity or outcomes [47,60], and abnormal levels on MRI do not always correspond to abnormal clinical-physical examination levels [70]. In a study of 98 patients with cervical radiculopathy, the agreement between patients' pain drawing and MRI findings for segmental level was poor, and the interclinical agreement was fair to moderate [155,156]. However, the recent development of newer sequences and reconstructions offer promising ability to overcome such limitations by improving the assessment of osseous nerve root compression, improving the visualization of nerve roots, and increasing the correlation with surgical findings [157-160].

Variant 8: Adult. Chronic cervical pain with radiculopathy. No trauma or "red flags." Initial imaging.

N. Radiographic myelography cervical spine

CT myelography has supplanted radiographic myelography in this indication. Radiographic myelography is not a first-line imaging modality for this indication.

Variant 8: Adult. Chronic cervical pain with radiculopathy. No trauma or "red flags." Initial imaging.

O. Radiography cervical spine

Radiographs are frequently acquired in patients with cervical radiculopathy. In a study of 1,581 patients between 18 and 97 years of age, 53.9% of individuals demonstrated disc degenerative changes, with prevalence and severity increasing with age [67]. However, the association of these findings with clinical symptoms remains unclear [67]. The addition of flexion and extension views

may be helpful in the detection of degenerative cervical spondylolisthesis in suspected cases of instability [71].

Variant 8: Adult. Chronic cervical pain with radiculopathy. No trauma or "red flags." Initial imaging.
P. Radiography cervical spine flexion extension lateral views

Radiographs are frequently acquired in patients with cervical radiculopathy. In a study of 1,581 patients between 18 and 97 years of age, 53.9% of individuals demonstrated disc degenerative changes, with prevalence and severity increasing with age [67]. However, the association of these findings with clinical symptoms remains unclear [67]. The addition of flexion and extension views may be helpful in the detection of degenerative cervical spondylolisthesis in suspected cases of instability [71].

Summary of Highlights

This is a summary of the key recommendations from the variant tables. Refer to the complete narrative document for more information.

- **Variant 1**: In an adult with acute or increasing cervical pain without radiculopathy, trauma, or "red flag symptoms," radiographs of the cervical spine may be appropriate, per clinician discretion, as an initial imaging assessment.
- **Variant 2**: In an adult with acute or increasing cervical pain with radiculopathy without trauma or "red flag symptoms," radiographs and MRI of the cervical spine without IV contrast may be appropriate initial imaging modalities for assessment.
- **Variant 3**: In an adult with prior cervical spine surgery with acute or increasing mechanical cervical pain with no trauma or "red flags," radiographs of the cervical spine are usually appropriate because radiographs can assess the alignment of the cervical spine and integrity of the hardware. Cervical spine lateral radiographs with flexion and extension are usually appropriate because dynamic flexion and extension views improve the assessment of solid fusion and detect instrument instability. CT of the cervical spine is also usually appropriate, because CT allows for evaluation of the hardware relationship to bones, nerves, spinal canal, and bone continuity at the fusion site. CT also offers superior ability to radiographs to detect bridging trabeculation in cages. CT myelogram of the cervical spine may be appropriate in providing an excellent alternative to MRI in assessing the spinal canal and neural foramina in degenerative disease when MRIs are nondiagnostic, secondary to extensive hardware artifacts. In patients with prior cervical spine surgery, an MRI of the cervical spine without IV contrast is usually appropriate and offers the benefit of detection of adjacent level disease, including disc herniations and nerve impingement. The addition of contrast to MRI cervical spine without IV contrast may be appropriate in some cases, depending on the surgical approach.
- **Variant 4**: In an adult with suspected or known spine infection with acute or increasing cervical pain with or without radiculopathy, an MRI of the cervical spine with and without IV contrast is an appropriate initial imaging modality for assessment. MRI offers excellent evaluation of bone marrow, and the addition of contrast improves the detection and characterization of complications such as epidural abscess, meningitis, and myelitis. MRI of the cervical spine without IV contrast may be appropriate for assessment of marrow, disc space, and epidural collections. CT of the cervical spine without IV contrast may be appropriate as it offers early detection of bone abnormalities, including osteolysis, bone

erosions, and endplate irregularities. The addition of contrast to CT may be appropriate for initial imaging because it allows for the detection of peripherally enhancing adjacent collections. Contrast can also aid in detecting epidural collections and mass effect on the opacified venous plexus and can aid in assessing thecal sac compression.

- **Variant 5**: In an adult patient with malignancy and acute cervical pain or radiculopathy, an MRI of the cervical spine without and with IV contrast is an appropriate first imaging modality. MRI is sensitive for detecting early marrow changes and can detect very early changes in the bone marrow space. MRI is the most sensitive imaging modality for the assessment of soft tissue abnormalities, including cervical spine soft tissues. This makes MRI the modality of choice for evaluation of tumor extension into surrounding soft tissues, including prevertebral soft tissue, epidural space, and neural foramina. MRI allows for a better assessment of spinal cord compression and spinal cord signal abnormality. The addition of IV contrast can further aid in the assessment of soft tissue extension, including epidural disease, leptomeningeal involvement, and intramedullary involvement. MRI of the cervical spine without IV contrast may be appropriate because it offers similar advantage to MRI of the cervical spine without and with IV contrast but is less sensitive for detecting soft tissue extension to the spinal canal and detecting leptomeningeal involvement. CT cervical spine without IV contrast may be appropriate because it offers excellent detection of bone involvement. The addition of contrast may be appropriate because it aids in detecting soft tissue involvement. FDG-PET/CT may be appropriate because it offers the advantage of simultaneous detection of skeletal and extraskeletal disease and assessing the entire spine.
- **Variant 6**: In an adult with cervicogenic headache, MRI of the cervical spine without IV contrast may be appropriate as an initial imaging modality because it offers an assessment of degenerative disease, including facet arthropathy, and allows for evaluation of alternative pathology for cervical pain.
- **Variant 7**: In an adult with chronic cervical pain without radiculopathy, trauma, or "red flag symptoms," radiographs of the cervical spine may be an appropriate initial imaging modality because it serves as an initial screen for spondylosis, degenerative disc disease, and malalignment. MRI of the cervical spine without IV contrast may also be an appropriate initial imaging modality because it offers similar advantages to radiographs with the added value of assessment of the soft tissues, including the neural foramina, spinal canal, and spinal cord.
- **Variant 8**: In an adult with chronic cervical pain with radiculopathy and no trauma or "red flag symptoms," MRI of the cervical spine without IV contrast is usually an appropriate first imaging modality. MRI is the modality of choice for assessment of soft tissue abnormalities, including assessment of suspected nerve root impingement in patients with chronic cervical radiculopathy. Radiographs may be an appropriate initial imaging modality because they can offer an initial screening imaging modality for cervical radiculopathy, but the association of imaging findings on radiographs and imaging is not always direct. CT cervical spine without IV contrast may be an appropriate initial imaging modality in chronic cervical radiculopathy because it allows for the assessment of potential nerve impinging osseous structures such as osteophytes, uncovertebral joints, and facet joints.

Supporting Documents

The evidence table, literature search, and appendix for this topic are available at https://acsearch.acr.org/list. The appendix includes the strength of evidence assessment and the final rating round tabulations for each recommendation.

For additional information on the Appropriateness Criteria methodology and other supporting documents, please go to the ACR website at https://www.acr.org/Clinical-Resources/Clinical-Tools-and-Reference/Appropriateness-Criteria.

Gender Equality and Inclusivity Clause

The ACR acknowledges the limitations in applying inclusive language when citing research studies that predates the use of the current understanding of language inclusive of diversity in sex, intersex, gender, and gender-diverse people. The data variables regarding sex and gender used in the cited literature will not be changed. However, this guideline will use the terminology and definitions as proposed by the National Institutes of Health.

Appropriateness Category Names and Definitions

Appropriateness Category Name	Appropriateness Rating	Appropriateness Category Definition
Usually Appropriate	7, 8, or 9	The imaging procedure or treatment is indicated in the specified clinical scenarios at a favorable risk-benefit ratio for patients.
May Be Appropriate	4, 5, or 6	The imaging procedure or treatment may be indicated in the specified clinical scenarios as an alternative to imaging procedures or treatments with a more favorable risk-benefit ratio, or the risk-benefit ratio for patients is equivocal.
May Be Appropriate (Disagreement)	5	The individual ratings are too dispersed from the panel median. The different label provides transparency regarding the panel's recommendation. "May be appropriate" is the rating category and a rating of 5 is assigned.
Usually Not Appropriate	1, 2, or 3	The imaging procedure or treatment is unlikely to be indicated in the specified clinical scenarios, or the risk-benefit ratio for patients is likely to be unfavorable.

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, because of both organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared with those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document.

Relative Radiation Level Designations

Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
O	0 mSv	0 mSv
☢	<0.1 mSv	<0.03 mSv
☢☢	0.1-1 mSv	0.03-0.3 mSv
☢☢☢	1-10 mSv	0.3-3 mSv
☢☢☢☢	10-30 mSv	3-10 mSv
☢☢☢☢☢	30-100 mSv	10-30 mSv

*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (e.g., region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies."

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Disclaimer

The ACR Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the FDA have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.

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