Clinical Practice Guideline: **X-Ray Guidelines**

Date of Implementation: **March 13, 2003**

Product: **Specialty**

Related Policies:
CPG 58: Nasium & Vertex X-Ray Views
CPG 102: Radiographic Quality and Safety Parameters
CPG 110: Medical Record Maintenance and Documentation Practices

Table of Contents

1. GENERAL INDICATIONS FOR RADIOGRAPHIC EXAMINATION

Radiographs are recommended when clinical history and physical examination reveal signs and symptoms of potentially serious underlying conditions (red flags). But, "on its own, an isolated 'red flag' may have a high false positive rate for the diagnosis of underlying spinal pathology, such as cancer. For example, the presence of a solitary 'red flag' such as age over 50 years may not be sufficient to warrant taking spine radiographs". Clinicians should "combine sound medical judgment and the assessment of red flags when ordering radiographic examinations" (Corso et al., 2020).

In many circumstances, especially when there is significant risk for spine injury, computed tomography (CT) or magnetic resonance imaging (MRI) are the initial imaging modalities. For patients with clinical suspicion of spinal cord injury or compromise, as well as ligamentous injuries, particularly in the cervical spine, MRI is preferred over CT and radiography (American College of Radiology, 2022).

Proper patient selection involves balancing the established benefits of the clinical information obtainable from a radiograph with the potential for unnecessary harm. Radiographs, like other diagnostic studies, should only be considered if the study is likely to:

1. Yield important information necessary for appropriate management of the patient beyond that obtained from the history and physical examination; and
2. Improve patient outcomes.

To be appropriately applied, radiographs should meet three levels of clinical justification prior to being acquired. First, there should be a general expectation of benefits exceeding harms. Second, radiographs should possess the performance characteristics to be responsible arbiters of the clinical information being sought. Third, the first and second levels should translate into tangible value to the individual patient being evaluated. In other words, clear benefits, should accrue to each individual patient based on value and performance of radiographs for the chosen indication. (Holmberg, 2010)

Avoiding imaging for patients without documented specific clinical indicators supporting the need for imaging (primary diagnosis, secondary diagnosis, or co-morbid condition) can prevent unnecessary harm and unintended consequences to patients. Refer to the Appendix (Quality Indicators Related to Imaging for Low Back Pain – Adults Ages 18-75) of this policy for more information.

2. RADIOGRAPHIC QUALITY AND SAFETY

While exposure to ionizing radiation for diagnostic purposes poses a risk to human health, its use can be tailored to produce diagnostically or therapeutically significant information for clinicians while minimizing harm. Scientific evidence clearly supports the medical

necessity of appropriate radiographic examination with exposures that are consistent with the "as low as reasonably achievable" (ALARA) principal when the information received from the exam is essential to ascertain the safety and appropriateness of planned treatment interventions. Refer to *Radiographic Quality and Safety Parameters (CPG 102 – S)* for additional information.

3. EVIDENCE FOR POTENTIAL REASONS TO OBTAIN SPINAL RADIOGRAPHY

Manual manipulation has been shown to provide significant benefit to patients with certain types and severity of mechanical disorders. However, manual manipulation can also cause harm if the procedure is performed in a manner or location contraindicated by underlying pathology or structural deformity. Performing manual manipulation requires a clear understanding of the biomechanics of the affected and related structures. In the majority of cases, the mechanical characteristics of the patient's presenting symptoms can be assessed through history and clinical examination alone. However, in some cases, it is necessary for the physician to request a radiographic examination to augment diagnostic history and examination in order to fully understand the risks and benefits of high load manual procedures to the osseous structures of the body. The number of views taken to adequately assess the osseous structures will be dictated by the various indications identified via the history and physical examination (and, on occasion, additional plain imaging views or other diagnostic tests such as electrodiagnostic, advanced imaging or laboratory examination). This Clinical Practice Guideline provides a description of those evaluation factors that may indicate such a need for obtaining radiographs.

Radiography is the most widely used skeletal imaging method. The primary value of plain imaging is to show pathologies of bone or joint structures, especially if there is a suspicion of inflammatory, neoplastic, metabolic, or traumatic disease. Plain imaging coupled with information from thorough history and examination procedures is generally considered acceptable for identifying therapeutically significant musculoskeletal pathology. Pathology is best ruled out through the appropriate assessment of red flags identified through careful history and physical examination combined with appropriate diagnostic triage.

Serious pathology and traumatic injury are rare causes of spinal pain. Various studies have found the incidence of serious pathology presenting as low back pain in primary care settings to be between 0.2 and 3.1%, and fracture to be between 0.2 and 6.6%. Clear clinical and historical indicators generally exist to suggest the potential presence of these conditions; therefore, routine use of X-ray imaging to diagnose these conditions is not recommended due to the rarity of these presentations in clinical practice. Furthermore, recent evidence informed consensus suggests referral for MRI and blood tests, rather than

X-ray, as the preferred investigation when serious pathology such as cancer or infection is suspected (Jenkins et al., 2018).

Spinal X-ray imaging may also be used to diagnose more benign spinal findings such as degenerative arthritis, spondylolisthesis, and transitional vertebral segments. An important consideration, however, is whether these radiographic findings lead to a change in patient management. Many of these radiographic findings, although relatively common, show either no or weak association with symptomatology, making their clinical relevance questionable. Furthermore, there is no high-quality evidence to demonstrate that patient management should be modified based on presence of benign radiographic findings that could not be determined from patient clinical history or exam alone. Current chiropractic clinical practice guidelines do not differentiate between treatment options based on the presence or absence of these benign radiographic findings. Therefore, based on the evidence, the use of X-ray imaging to diagnose benign spinal findings will not improve patient outcomes or safety (Jenkins et al., 2018).

A common reason suggested by chiropractors for spinal X-ray imaging is to screen for anomalies or serious pathology that may contraindicate treatment that were otherwise unsuspected by the clinical presentation. While some cases of serious pathology, such as cancer and infection, may not initially present with definitive symptoms, X-ray assessment at this early stage of the disease process is also likely to be negative, and is not recommended as a screening tool. The development of symptoms, which would then indicate the need for imaging referral, often reflects progression of the underlying pathology, and therefore an increased likelihood of observing related imaging findings. However, even in symptomatic patients, MRI rather than X-ray is recommended as the initial imaging modality due to the higher sensitivity of MRI for the detection of pathological changes. Pathological causes of back and neck pain are rare, and even fewer cases would be asymptomatic, further reducing the potential benefit of routine imaging. Furthermore, imaging referral consistent with current imaging guidelines has not been shown to have an increased risk of missing serious pathology. Therefore, routine imaging (including spinal X-rays) for unsuspected serious pathology is not supported by evidence.

Anatomical anomalies in the upper cervical spine, such as agenesis of the dens and fusion of the occiput and atlas, have been postulated to be associated with increased upper cervical instability or neural compromise that may contraindicate manipulative therapy. These anomalies present with varied symptomatology, and can be difficult to clinically diagnose, thus X-ray screening has been suggested. However, the contraindication of manipulative therapy for patients with these anomalies is on a theoretical basis, rather than documented clinical evidence of harm. A scoping review of risks of manual treatment to the spine did not identify any reports of harm after manipulative therapy that were attributed to the presence of upper cervical anatomical anomalies. Prevalence rates of upper cervical

anatomical anomalies are also low (between 2.1 to 3.7%). The low prevalence, combined with uncertain clinical significance suggests that the use of routine X-ray to screen for congenital anomalies in asymptomatic patients is not supported by evidence (Jenkins et al., 2018).

Recent literature reviews conclude there is insufficient evidence for using plain X-rays for biomechanical analysis or to assess the function or structure of the spine, including but not limited to the detection and characterization of subluxation(s). Two exceptions exist to this conclusion. First, radiographs for the initial evaluation of scoliosis or in rare cases where clinical progression of a scoliosis necessitates additional radiographs for surgical consultation. Second, radiographs for evaluation of intersegmental instability when correlated with evidence obtained through a careful history and physical examination.

The use of spinal X-ray imaging has been postulated to be important to help direct appropriate chiropractic management, where specific X-ray findings would lead to a change in the type of technique modality selected. However, no studies could be found assessing the impact of routine imaging on technique modality selection resulting in improved patient outcomes. While there are many different technique modalities used within chiropractic practice, there is a lack of high-quality evidence to indicate which technique modalities are superior for a given condition. Furthermore, spinal X-ray has not been found to be a useful method to determine the site of spinal manipulation. For usual medical care of non-specific back or neck pain, studies show no difference in treatment outcome when routine spinal X-rays have been used, compared to management without X-rays. Therefore, without any clear evidence of the benefit of using spinal X-ray to direct treatment modality selection, clinician selection of modality should be made based on the clinical presentation, and the use of initial X-ray confirmation is not justified.

The use of imaging to reassure patients that they have no underlying pathology has been reported as a potential reason for imaging referral. Patients often expect imaging for the management of back pain, largely because they believe that it will help to diagnose their pain and direct suitable treatments. However, routine use of imaging has been associated with a lesser sense of wellbeing, and lower overall health status. Other strategies to reassure the patient such as education and explanation of evidence about the use of routine imaging should be used as a first approach (Jenkins et al., 2018).

Spinal X-rays may lead to the detection of radiographic findings of uncertain clinical significance, leading to unnecessary diagnosis (overdiagnosis). X-ray findings, such as osteophytes, reduced disc height, spondylolisthesis, transitional segments, and other anatomical anomalies are common, but show poor correlation with clinical symptoms. For patients without indicators of serious pathology, the increase in information available from X-ray confers little additional benefit to patient health but may unnecessarily increase

patient concern and thus contribute to low value care. Overdiagnosis may create unwarranted concern for the patient and a misguided belief in a pathoanatomical cause to their pain. Patients may believe that their pain will not improve until the imaging findings have resolved, which may increase the risk of developing chronic pain. Overdiagnosis may also contribute to fear-avoidance behaviors, where patients are less likely to follow management advice (e.g., maintaining exercise and physical activity) for fear of further damage. Early imaging of the low back has been associated with resultant increased disability, a lesser sense of well-being, and lower health status (Jenkins et al., 2018).

Radiographs should **not** be used as a screening procedure or for medicolegal reasons. Without specific clinical indications from the history and examination supporting the need for imaging (differential diagnoses for which radiographic imaging meets the performance thresholds for use are reasonably possible), radiographic imaging is not supported. If prior imaging of the area in question has been performed at another facility, all reasonable attempts should be made to obtain the results of those studies prior to considering further imaging.

4. GUIDELINE SUMMARY OF CLINICAL INDICATORS FOR RADIOGRAPHY

The written or electronic request for a radiograph should provide sufficient information to demonstrate the medical necessity of the examination and allow for its proper performance and interpretation. Documentation that satisfies medical necessity includes (1) signs and symptoms, and/or (2) relevant history (including known diagnoses). Additional information regarding the specific reason for the examination or a provisional diagnosis would be helpful and may, at times, be needed to allow for the proper performance and interpretation of the examination (American College of Radiology, 2022).

According to the American College of Radiology, there are many indications for radiography that relate to the patient's clinical history, the disease processes, and the anatomic areas of concern. There should be sufficient clinical indication(s) to warrant performance of a study, and a reasonable anticipation that the results of the radiograph, normal or abnormal, will influence the treatment course of the patient. This guideline is designed to assist you in the imaging decision process.

Radiographs are an important diagnostic tool in patient management when clinical indicators of serious pathologies (red flags) are present. It should be recognized that adherence to this guideline will **not** assure an accurate diagnosis or a successful outcome. The following discussion of clinical indicators may help inform the decision to obtain radiographs; however, the clinical presentation as a whole must be considered.

4.1. Red Flag Indicators from History and Physical Examination

4.1.1 Fracture, Dislocation, Ligamentous Incompetence:

- Recent injury or trauma (at any age) sufficient to cause fracture such as a motor vehicle collision (MVC), blunt trauma, or fall, especially from height. A reasonable attempt should be made to obtain previous studies/reports if prior imaging was performed in the emergency center;
- Age over 70 accompanied by historical factors or physical examination findings that would raise suspicion of fracture;
- History of osteoporosis or any known disease that could lead to bone loss and minor trauma such as lifting, accompanied by localized bone pain;
- History of repetitive stress sufficient to cause a stress fracture (e.g., patients participating in contact sports, gymnasts, and/or laborers who perform heavy repetitive lifting);
- Prolonged use of oral corticosteroid or other medications known to increase bone fragility accompanied by historical factors and physical examination findings that would raise suspicion for fracture;
- Suspicion or known history of spondylolisthesis for which symptoms suggest spinal stenosis with progressive neurologic deficits;
- Suspicion of physical abuse (at any age) and exam findings that raise suspicion for fracture;
- History of alcohol and/or drug abuse where the abused substances may result in loss of consciousness or poor recollection of activities or actions that could include trauma sufficient to cause fracture **and** symptoms or clinical presentation suggestive of fracture; and
- Failure to improve with an appropriate trial of care (typically up to 4 weeks), without prior radiographs and especially when accompanied by historical factors or physical examination findings that would raise suspicion of fracture or other suspected pathology explaining causes of the patient's pain.

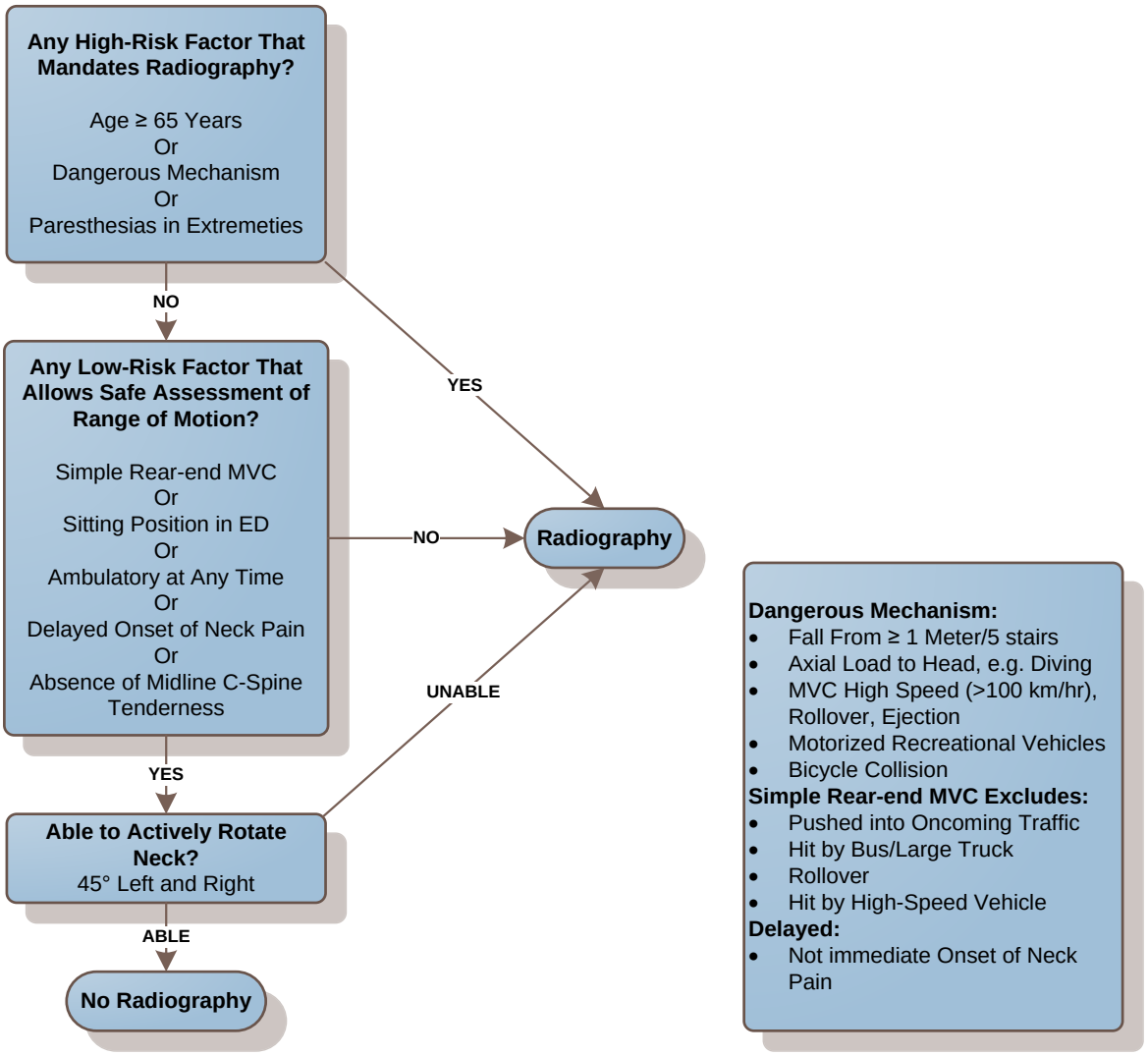
Established Clinical Decision Assist Tools for Determining the Medical Necessity of Radiographs following Recent Acute Trauma:

The Canadian C-spine Rule (CCR) was developed to help physicians determine which alert (Glasgow Coma Scale (GCS)=15), stable, trauma patients need cervical spine imaging.

CCR Not Applicable if:

- Non-trauma Patients
- GCS <15
- Unstable Vital Signs

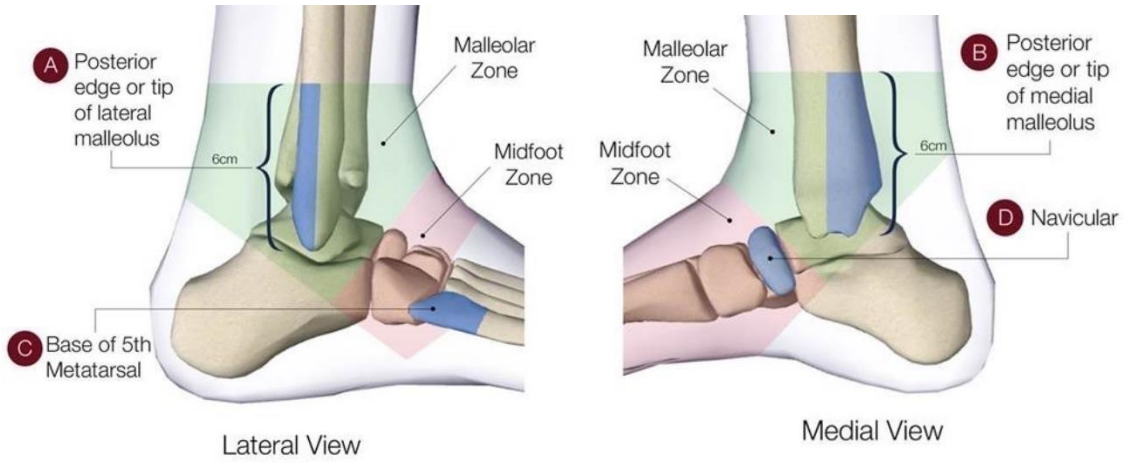
- Age <16 Years
- Acute Paralysis
- Known Vertebral Disease
- Previous C-Spine Surgery



The **National Emergency X-Radiography Utilization Study (NEXUS)** guidelines suggest a low probability of cervical spine injury that will require cervical spine imaging if the patient meets all five of the following criteria:

- They do not have tenderness at the posterior midline of the cervical spine
- They have no focal neurological deficit
- They have a normal level of alertness (GCS=15)
- They have no evidence of intoxication
- They do not have a clinically apparent, painful injury that might distract them from the pain of cervical-spine injury.

The **Ottawa ankle rules** are a clinical decision-making strategy for determining which patients require diagnostic imaging for ankle and mid-foot trauma.



Ottawa Ankle and Foot Rules:
An ankle X-ray is required only if there is any pain in a malleolar zone and any of these findings:

- Bone tenderness at A
- Bone tenderness at B
- Inability to weight bear four steps both immediately and in the emergency department

A foot X-ray is required if there is any pain in the midfoot zone and any of these findings:

- Bone tenderness at C
- Bone tenderness at D
- Inability to weight bear four steps both immediately and in the emergency department

Clinical judgement should prevail over the Ottawa Ankle Rules if the patient

- Is intoxicated or uncooperative
- Has other distracting painful injuries
- Has diminished sensation in their legs
- Has gross swelling which prevents palpation of the malleolar bone tenderness

Tips relative to the Ottawa Ankle Rules:

- Palpate the entire distal 6cm of the fibula and tibia
- Do not neglect the importance of medial malleolar tenderness

- "Bearing weight" counts even if the patient limps
- Be cautious in patients under age 18
- Several studies strongly support the use of the Ottawa Ankle Rules in children over 6 (98.5% sensitivity); however, their usefulness in younger children (<6 years old) has not yet been thoroughly examined
- The Ottawa ankle rules should be applied to patients in the setting of acute trauma for the evaluation of a potential fracture. Indications for imaging the foot and ankle outside the setting of trauma for pathologies other than a fracture may still exist and are not addressed by these rules.

The **Ottawa knee rules** are a clinical decision-making strategy for determining which patients require diagnostic imaging for knee trauma.

Ottawa Knee Rules
A knee X-ray is only required for knee injury patients with any of these findings:

- Age 55 or over
- Isolated tenderness of the patella (no bone tenderness of the knee other than the patella)
- Tenderness at the head of the fibula
- Inability to flex to 90 degrees
- Inability to weight bear both immediately and in the emergency department (four steps - unable to transfer weight twice onto each lower limb regardless of limping)

Tips relative to the Ottawa knee rules:

- Tenderness of the patella is significant only if an isolated finding
- Use only for injuries < 7 days
- "Bearing weight" counts even if the patient limps
- The Ottawa knee rules should be applied to patients in the setting of acute trauma for the evaluation of a potential fracture. Indications for imaging the knee outside the setting of trauma for pathologies other than a fracture may still exist and are not addressed by these rules.

The **Pittsburgh knee rules** are a clinical decision-making strategy for determining which patients require diagnostic imaging for knee trauma.

Pittsburgh Knee Rules

- Blunt trauma or fall as a mechanism of injury

Plus, either of the following:

- Age <12 years or >50 years

- Inability to bear weight (4 steps)

The Pittsburgh knee rules are often thought of in the context of the Ottawa knee rules. Some believe the Pittsburgh knee rules offer increased specificity.

The Pittsburg knee rules only count a complete heel/toe plant as a step.

The Pittsburgh knee rules do not apply to individuals who present more than 6 days after injury, those with only superficial lacerations and abrasions, those with a previous history of knee injury or surgery on the affected knee, and those being reassessed for the same injury.

4.1.2 Neoplasia: Cancer/Malignancy/Tumor

- History of malignancy with suspicious physical examination findings (e.g., acute localized bone pain);
- Age over 50 or under 20 with unexplained localized bone pain;
- Non-mechanical pain (e.g., severe ongoing pain, especially at night, that is unrelenting, unrelieved by rest or position and unrelated to movement);
- Severely restricted lumbar flexion that is not improving when correlated with other factors from history and physical examination;
- The presence of a palpable mass or unexplained deformity;
- Unexplained weight loss (i.e., unintentional weight loss of 4.5 Kg or 10 lbs. or greater over preceding 6 months);
- Systemic unwellness;
- Symptoms of HIV, or other risk factors that may be red flags for tumor; and
- Failure to improve with an appropriate trial of care (typically up to 4 weeks), without prior radiographs and especially when accompanied by historical factors or physical examination findings that would raise suspicion of neoplasia or other suspected pathology explaining the patient's pain.

Coordinate appropriate co-management when red flags are present for cancer/malignancy/tumor/pathological fracture, even if radiographs appear to be normal. Radiography may be appropriate but are usually not sufficient for clinical decision making without advanced imaging (i.e., MRI, CT) when red flags are present for these conditions. Co-management must be considered when suspicion for these conditions arises.

4.1.3 Infection (e.g., Discitis, Osteomyelitis)

- Presence of bruising, swelling, redness heat, indicating infection especially for extremity conditions.

- Non-mechanical pain (e.g., severe ongoing pain, especially at night, that is unrelenting, unrelieved by rest or position and unrelated to movement);
- Symptoms of urinary tract infection, IV drug abuse, HIV, or other risk factors that may be red flags for infection;
- Constitutional symptoms such as recent fever of unknown origin greater than 101°, chills, localized bone pain, and lymphadenopathy raising suspicion for osteomyelitis;
- Intermittent fever of unknown origin with focal musculoskeletal pain and/or deformity;
- Mono-articular inflammatory joint pain that does not have a clear explanation of origin;
- Severely restricted lumbar flexion that is not improving when correlated with other factors from history and physical examination; and
- Failure to improve with an appropriate trial of care (typically up to 4 weeks), without prior radiographs and especially when accompanied by historical factors or physical examination findings that would raise suspicion of infection or other suspected pathology explaining the patient's pain.

Coordinate appropriate co-management actions when red flags are present for infection, even if radiographs appear to be normal. Radiography may be appropriate but are usually not sufficient for clinical decision making without other diagnostic testing (i.e., labs, MRI, CT). Co-management must be considered when suspicion for infection arises.

4.1.4 Other Indicators Requiring Clinical Correlation and Possible Co-management

[**Note:** Correlation with clinical findings {for example, a true neurological deficit}, suggestive of a condition detectable by a radiographic study is necessary. Also, a reasonable anticipation that the results of the radiograph, normal or abnormal, will influence the treatment course and clinical outcomes.]

- Signs indicating cauda equina syndrome such as saddle dysesthesia (found in 75% of patients with cauda equina syndrome), urinary frequency, incontinence, or possible neurological deficit require urgent surgical consultation. Radiographs are no longer considered as an initial imaging procedure;
- Focal and progressive neurological deficits (e.g., Abnormal Reflexes [DTRs, Pathological], Myotomes and/or Dermatomes) suggestive of compressive lesions to the spinal cord or nerve roots **if** bony stenosis due to severe degenerative disease or segmental listhesis is suspected. Other causes of neurologic deficit, such as cord tumor or herniated nucleus pulposus are more effectively evaluated with advanced imaging modalities such as MRI;
- Bilateral radiculopathy;

- Active or inactive spondylolysis and spondylolisthesis must be considered in patients under the age of 20 presenting with recurrent spinal pain accompanied by other key historical factors (participating in sports that cause the patient to perform repetitive hyperextension of the lumbar spine such as gymnastics, wrestling, diving, and weightlifting). Special testing (MRI) may be indicated in patients with suspected spondylolysis and spondylolisthesis when historical and physical examination findings warrant the need;
- Recurring pain of unknown origin with no indication by history, treatment, or examination findings of a mechanical basis for the recurring pain and no radiographs or reliable reports are available. A reasonable attempt should be made to obtain previous studies/reports if prior imaging was performed within 2 years;
- Previous history of surgery, fracture, or X-ray abnormality in the area of complaint as reported by the patient but no radiographs or reliable reports are available. A reasonable attempt should be made to obtain previous studies/reports if prior imaging was performed within 2 years;
- The presence of historical factors or physical examination findings that would raise suspicion for traumatic, inflammatory, or degenerative spinal instability sufficient to be a contraindication to manual manipulative treatment. This is especially a concern at the Atlas-Axis articulation.
- History includes complaint(s) of dizziness or impaired consciousness of unknown origin;
- For headache complaints, vital signs (to exclude severe hypertension or fever) and testing of the cranial nerves (to exclude vascular events, space occupying lesions) must be considered and when present positive findings mandate further evaluation and possible co-management. Radiographs (e.g., cervical spine) are not typically indicated without other red flags that would justify the value of a radiographic study;
- Presence of Dysphagia;
- Poorly controlled diabetes may be associated with bone loss and diffuse idiopathic skeletal hyperostosis (DISH);
- Poorly controlled chronic hypertension may be associated with increased risk of aneurysm. Radiography is not considered an appropriate initial imaging modality. The presence of a Pulsatile, Abdominal Mass or suspected Abdominal Aortic Aneurysm would indicate the necessity for co-management and other imaging (Ultrasound Aorta Abdomen, CTA, MRA) prior to performing spinal manipulation.
- Clinical suspicion of and/or positive lab findings (if applicable) for arthropathies such as rheumatoid arthritis ankylosing spondylitis, neuropathic arthropathy, crystal induced arthropathy or other autoimmune inflammatory arthropathies;
- Presence of metabolic diseases (e.g., osteoporosis), nutritional deficiencies, and skeletal changes from systemic disease;

- Presence of congenital syndromes and developmental disorders;
- Symptoms and signs that suggest pain or deformity from non-spinal causes such as soft tissue masses causing bone or articular pain, renal lithiasis, or vascular abnormalities such as aneurysm;
- Prolonged drug, smoking and/or alcohol abuse;
- When evaluation of soft tissues in an extremity is warranted (e.g., suspected foreign body, myositis ossificans);
- Evaluation of gross deformities;
- Immunosuppression;
- Lymphadenopathy;
- Evaluation of developmental hip dysplasia in the pediatric population;
- Evaluation of Leg-Calve-Perthes disease;
- Evaluation of slipped capital femoral epiphysis in the pediatric population; and
- Limping or refusal to bear weight, especially in children.

4.2. Radiography Studies/Services

4.2.1 Full Spine Radiography

- Full spine (14 x 36) radiographs should not be used as a routine screening procedure for scoliosis or any other global spinal postural dysfunction;
- Full spine (14 x 36) radiographs should not be utilized as a substitute for sectional views;
- Full spine (14 x 36) radiographs are rarely indicated for patients who have reached skeletal maturity;
- Full spine (14 x 36) radiographs may be appropriate only for initial evaluation of a previously undiagnosed scoliosis when, upon inspection, the patient appears to have a significant scoliosis with a rib hump present and Adam's position confirms a structural problem;
- For children, the number of views required for complete evaluation of scoliosis varies with the clinical indications. For scoliosis screening, a posteroanterior (PA) radiograph of the spine obtained in the upright position may be sufficient. The field of view should extend from the cervicocranial junction to the proximal femurs;
- For a scoliosis evaluation, erect sectional radiographs provide better detail. Standing full-length PA (14 × 36 in) and lateral projections, **or** sectionals may be performed;
- PA radiographs significantly reduce breast and thyroid dose. Effective doses to the digestive and respiratory systems are comparable, but are higher in the bone marrow compared to AP views;
- Full spine radiographs are not recommended for patients with an AP measurement > 28 cm or for older patients due to poor image quality. Consider using sectional radiographic views instead; and

- Sectional studies (e.g., cervical spine AP/Lateral and lumbar spine AP/Lateral on the same patient) should only be acquired on relevant spinal regions that meet the criteria above. Thus, sectional images of all three spinal regions should only be obtained if significant indications exist to justify each and every region's acquisition.

4.2.2 Scoliosis and Related X-Ray Study (CPT® Codes 72081, 72082, 72083, 72084)

Scoliosis in children is classified by age: Infantile (0 to 3 years); Juvenile (3 to 10 years); and Adolescent (age 11 and older, or from onset of puberty until skeletal maturity).

Scoliosis that occurs or is diagnosed in adulthood is distinctive from childhood scoliosis, since the underlying causes and goals of treatment differ in patients who have already reached skeletal maturity. Most adults with scoliosis can be divided into the following categories: (1) Adult scoliosis patients who were surgically treated as adolescents; (2) Adults who did not receive treatment when they were younger; and (3) Adults with a type of scoliosis called degenerative scoliosis (American Association of Neurological Surgeons (AANS), (n.d.)).

A positive diagnosis of scoliosis is made based on a coronal curvature measured on a posterior-anterior radiograph of greater than 10 degrees. In general, a curve is considered significant if it is greater than 25 to 30 degrees. Curves exceeding 45 to 50 degrees are considered severe and often require more aggressive treatment.

The prevalence rate of adult patients with nonpainful and nonprogressive scoliosis in healthy adults is >30% and may be as high as 68% in the elderly. Untreated adults with late-onset idiopathic scoliosis (LIS) are productive and functional at a high level at 50-year follow-up. Untreated LIS causes little physical impairment other than back pain (most only have minimal or moderate back pain) and cosmetic concerns. Patients with non-painful and nonprogressive scoliosis are unlikely to benefit from initial radiography as well as repeat evaluation and radiography.

Some patients with known scoliosis may present with significant disability. Back pain is the most common clinical problem presenting as a multiform mosaic of symptoms. Constant & nonspecific back pain has a poor prognosis. Other signs and symptoms may be radicular pain & claudication when standing or walking (from nerve traction or compression), neurologic deficit may include sphincter dysfunction. Curve progression and neurological status should be monitored, when indicated. For a patient observed to have scoliosis, clinical documentation must clearly describe that upon inspection the patient has a scoliosis with a rib hump present. Signs of scoliosis may include but are not limited to 1) a tilted head that does not line up over the hips; 2) one hip or shoulder that is higher than the other; 3) an obvious curve in the spine; 4) a protruding shoulder blade; 5)

leaning more to one side than the other. The presence of a rib hump is detected by the performance of the Adam's Forward Bend Test and is sensitive to detect trunk asymmetry. A structural problem is present when the abnormal curve does not correct (goes away, straightens out) when you bend forward and/or laterally (to the side). Also, a Scoliometer may be used. A trunk angle of 7°, using a Scoliometer, indicates a structural curve >20°. A neurologic exam including nerve root tension signs, motor power, sensations, deep tendon reflexes, and pathological reflexes should be performed, when indicated.

Multiple studies have shown that there is a decrease in radiation dose with digital imaging systems compared with conventional radiography. These systems should be preferentially employed for imaging of known or suspected scoliosis. A scoliosis series consists of images taken of the involved spinal regions (usually thoracic and/or lumbar spine). Other areas such as the cervical spine and sacrum/pelvis may be needed if clinically warranted. Typical views include standing, supine or lying down, and supine views with alternate right and left flexion. These images are taken to detect any curvature of the spine when scoliosis or other pathology may be present. A supine view will suffice if the patient is unable to stand (e.g., the very young child or patient with paralysis). An upright lateral radiograph facilitates assessment of sagittal deformity (abnormal kyphosis and lordosis), sagittal balance, and spondylolisthesis. Spondylolysis may be detected, although this is best evaluated with dedicated images when relevant. Report 72081 for one view; 72082 for two or three views; 72083 for four or five views; and 72084 for a minimum of six views. Acquiring these studies at 72 inches SID coupled with P-A positioning should be considered to reduce radiation exposure to reproductive, breast and thyroid regions.

When there is a confirmed diagnosis of scoliosis, there are several issues to assess that can help determine appropriate Diagnostic Imaging and Treatment options: (American Association of Neurological Surgeons (AANS), (n.d.))

- Spinal maturity – is the patient's spine still growing and changing?
- Degree and extent of curvature – how severe is the curve and how does it affect the patient's lifestyle?
- Location of curve – according to some experts, thoracic curves are more likely to progress than curves in other regions of the spine.
- Possibility of curve progression – patients who have large curves prior to their adolescent growth spurts are more likely to experience curve progression.

As with all X-ray studies, this procedure requires a written report of the findings. The following information must be clearly described: 1) the method of assessment (measurement) of the curvature; 2) the magnitude (amount) of the curvature (in degrees); 3) the direction of the curve (right = dextro, left = levo); 4) the vertebrae used to measure the curvature (ends and apex); 5) assessment of rotation; 6) skeletal maturity of the patient (Risser's sign); 7) cause; and 8) secondary complications.

4.2.3 Bone Length Study (CPT® Code 77073)

Bone length studies accurately measure the length of the long bones in the skeleton. Typically, four film exposures are performed during a scanogram; however, there is no number or type of views specified for this code. Views of the hip, leg, knee, and ankle are usually taken.

ASH considers bone length studies (either plain radiographic or CT scanogram) as described by CPT® code 77073 to be medically necessary when the following criteria are met:

1. A leg length discrepancy is noted of greater than or equal to 1.5 inches (3.8 cm) as measured from ASIS to ipsilateral bottom of medial malleoli AND diagnosis of any of the following conditions:
    a. Congenital anomalies (e.g., phocomelia and dysgenetic syndromes); acquired deformities (e.g., dysplasias, Ollier's disease, slipped epiphysis, poliomyelitis, neurofibromatosis, septic arthritis, juvenile OA, osteomyelitis, post-fracture/traumatic deformity, pes planus, knee valgus/varus and dislocation, surgically induced); growth plate injuries or surgery; OR inborn errors of metabolism.

If a CT scanogram or topogram of the lower extremities is all that is performed for leg measurement, then this is simply a radiograph performed on a CT scanner and CPT® code 77073 should be reported. The contralateral leg is studied for comparison purposes and should not be reported separately.

Due to the extent of variability in specificity and reliability of observation (subjectivity), Functional Leg Length Assessment cannot be relied upon for the purpose of validating subluxation (segmental joint dysfunction) or postural or mechanical dysfunction that would affect treatment decisions. See the *Functional Leg Length Assessment (CPG 88 - S)* and *Inserts and Other Shoe Modifications for Individuals without Diabetes (CPG 186 - S)* clinical practice guidelines for more information.

4.2.4 Stress Radiography

Stress radiography, when indicated, should not be performed until acute instability has been ruled out by clinical evaluation and there remains a question about whether undetected ligamentous instability exists. The neutral lateral projection should be evaluated, and the patient carefully examined before these exposures are taken. If severe instability is suspected, advanced imaging studies (MRI or CT) may be indicated prior to obtaining stress views.

Flexion-extension stress study of the cervical spine. This study should only be performed in a fully alert and cooperative patient. According to the American College of Radiology,

the patient should be able to voluntarily initiate and restrict head movement while these views are obtained. If the patient has limited cervical range of motion on physical examination, flexion and extension radiographs may be inadequate to exclude instability and MRI should be considered. Contraindications to these studies include vertebrobasilar ischemia, postural vertigo, fracture-dislocations, odontoid lesions, and significant neurological deficits. This study is indicated in the diagnosis of latent instability of the upper cervical spine to diagnose laxity or damage of the transverse ligament of the atlas caused by trauma or pathology affecting the ligament. The diagnosis is based on an abnormally wide space (greater than 3 mm in adults and 5 mm in children) between the posteroinferior margin of the anterior arch of the atlas and the anterior surface of the odontoid process. The most frequent causes include trauma, occipitalization, Down's syndrome, pharyngeal infections, inflammatory arthropathies (e.g., rheumatoid, ankylosing, psoriatic and Reiter's arthropathies). The minimum interspace is 1 mm in children and adults. A decreased space is to be expected with advancing age due to degenerative joint disease of the atlantodental joint.

Cervical lateral bending views are not generally used in the radiographic community and are considered to be of limited value.

Stress radiography of the thoracic and lumbar spine. Stress studies of the thoraco-lumbar spine are not supported by current scientific literature except in limited circumstances. Lateral bending studies may be indicated to assess the flexibility of a potentially progressive scoliosis. These studies are usually limited to determining fusion levels. On rare occasions, they may help differentiate between structural and nonstructural curves and help assess primary from secondary scoliotic curves. Lateral bending studies are done bilaterally with the patient supine, but the evaluation is primarily made from the radiograph taken when the patient is bending toward the side of convexity.

Flexion–extension views of the lumbar spine may be considered appropriate in the assessment of abnormal motion, such as might be found with an unstable spondylolisthesis. The clinical implications usually include failure to respond to conservative treatment and the need for consideration of surgical options. Routine use of flexion-extension views in the presence of spondylolisthesis is not supported.

4.2.5 Specifications of the Radiography Examination

Miscellaneous Radiography Examination Specifications

- Only standard projections are generally considered reasonable or necessary.
- Supplemental views should be obtained only when clinically indicated or when abnormal findings are found on an initial study but cannot be adequately characterized with standard projections.

- When imaging a symptomatic bone or joint, routine comparison images of the corresponding contralateral bone or joint generally are not indicated; however, limited comparison views may be helpful to verify or exclude pathology after initial review of the symptomatic extremity in some children. Certain pathologic processes may warrant simultaneous evaluation of both the right and left sides. This is particularly true for disorders of the hip, for which AP and frog-leg views of the entire pelvis are typically indicated.
- Knee AP weight-bearing views will often be used in the context of orthopedic appointments to assess the alignment and degree of arthropathy when weight-bearing. These views are often used to assess osteoarthritis as non-weight bearing views can underestimate the degree of joint space loss. It is common for the AP view to include both knees (CPT® Code 73565) so to use the contralateral side as a comparison.
- The American College of Radiology (ACR) Practice Parameter for the Performance of Radiography of the Extremities provides information summarized within the table below, which lists the minimum recommended extremity views in routine circumstances. In many instances, there is little or no scientific evidence in the literature to determine which views constitute the minimum requirement; thus, the recommendations in those instances reflect the opinions of the authors of the American College of Radiology per their Practice Parameter supported by expert opinion in the literature.

Minimum Recommended Routine Views of the Upper and Lower Extremities

Anatomic Area	**Views of the Upper Extremities:**
Scapula	AP and lateral (sometimes called "Y-view")
Clavicle	AP and AP angulated view
Acromioclavicular (AC) joint	Upright AP and outlet (lateral) view collimated to the AC joint
Shoulder	Two views, one of which should be AP or Grashey, and additional view(s) as indicated by clinical circumstances
Humerus	AP and lateral
Elbow	AP, lateral and radial head view for trauma patients
Forearm	AP and lateral
Wrist	PA, oblique, and lateral

Anatomic Area Views of the Upper Extremities:	
Hand	PA and oblique
Hand bone age	PA, left hand and wrist
Fingers	PA, oblique, and lateral
Anatomic Area Views of the Lower Extremities:	
Hip	AP and lateral (frog-leg, cross-table, or other lateral options)
Pelvis	AP
Femur	AP and lateral
Patella	Lateral and patellar/axial
Knee	AP and lateral (cross-table lateral recommended for trauma patients)
Tibia-fibula	AP and lateral
Ankle	AP, oblique (mortise), and lateral
Calcaneus	Lateral and axial
Foot	AP, oblique, and lateral
Toes	AP, oblique, and lateral

Cervical Spine Radiography Examination Specifications (Adults)

- Routine examination consists of anteroposterior (AP) and lateral views. More limited examinations may be performed for specific indications. Opposing (orthogonal) views, however, are generally required for a diagnostic assessment when choosing to image any area; single plane views are usually insufficient.
- In patients who have had cervical spine trauma, and for whom cervical spine CT is nondiagnostic or otherwise unavailable, the entire cervical spine from the craniocervical junction to at least the superior end plate of T1 should be performed to assess for multiple fractures or associated traumatic listhesis. Upright views are preferred but may not be possible if the patient's condition does not permit.
- In some clinical circumstances, additional evaluation may include some or all of the following: open mouth view (for assessment of dens and atlantoaxial association), closed mouth odontoid AP view (Fuchs view), oblique views (for assessment of the neural foramina), pillar views (for assessment of the facets), and flexion and extension lateral views (for assessment of cervical instability).

- A swimmer's lateral view may be performed, if necessary, to assess the lower cervical segments and C7/T1 alignment in patients who have had trauma or who have symptoms in this area that warrant radiography.
- A Davis series (i.e., A-P open mouth, A-P lower cervical, lateral, oblique, and flexion and extension views) is only appropriate when history and physical examination findings such as those that may be present following a significant whiplash trauma justify the need for the additional views that are included in this study.
- Nasium and Vertex X-ray views are unsupported. These are non-standard projections that are acquired solely for the purpose of detection of chiropractic subluxation, spinal postural and/or segmental juxtaposition measurements. Refer to *Nasium and Vertex X-Ray Views (CPG 58 – S)* for additional information.

Cervical Spine Radiography Examination Specifications (Children)

- Routine examination includes AP and lateral views. Lateral radiographs should be obtained in true lateral position with the neck in extension if possible, and preferably during inspiration. Some pediatric centers omit the frontal view.
- Oblique views are not recommended due to the added radiation and low diagnostic yield.
- Flexion and extension lateral views are often not possible in younger children but may be useful to assess for ligament laxity in older children.
- Odontoid views are difficult to acquire in children younger than 5 years because of their short necks and imposition of the mandible on the spine and are not recommended.
- Cervical spine injury in young children (younger than 9 years old) most commonly occurs from the occiput through C3 and has a propensity for ligamentous or cartilaginous rather than osseous injury. Normal cervical spine radiographs do not exclude ligamentous or spinal cord injury.
- In older children with chronic cervical instability (especially those with Down syndrome), lateral radiographs of the cervical spine centered at the craniocervical junction are taken in 3 positions: active flexion, active extension, and the standard neutral view.

Thoracic Spine Radiography Examination Specifications (Adults)

- A standard routine examination includes AP and lateral views. Lower cervical or upper lumbar anatomy should be visualized to assure accurate numbering of thoracic levels. Collimation to reduce exposure to lateral-peripheral soft tissues in the abdomen to reduce radiation exposure and scatter formation should be present.
- Additional evaluation may be needed in some clinical circumstances and may include some or all of the following: swimmer's lateral view of the upper thoracic

region, oblique views, flexion-extension lateral views, lateral bending views, and spot view of the thoracolumbar junction.

Thoracic Spine Radiography Examination Specifications (Children)

- Routine examination includes AP and lateral views. Collimation to reduce exposure to lateral-peripheral soft tissues in the abdomen to reduce radiation exposure and scatter formation should be present.
- Additional views may be obtained for specific clinical indications.

Lumbosacral Spine Radiography Examination Specifications (Adults)

- A Standard examination includes AP and lateral views. Collimation to reduce exposure to lateral-peripheral soft tissues in the abdomen to reduce radiation exposure and scatter formation should be present. Some may choose a posterior/anterior (PA) view instead of an AP view to reduce radiation dosage.
- In many adults and occasionally in older children, additional evaluation may be needed and may include some or all of the following: Both oblique views, spot lateral view of the lumbosacral junction, angled AP view of the lumbosacral junction, and upright flexion and extension lateral views may be particularly helpful to assess for abnormal motion.
- The upper part of the sacrum is included in the standard lumbosacral examination. When a more complete evaluation of the sacrum, coccyx, or sacroiliac joints is needed, a cephalad-angled AP (Ferguson) view of the sacrum and bilateral oblique/sacroiliac views may be obtained. In select patients, dynamic coccygeal views or lateral seated position radiographs may demonstrate hypermobility or ligament laxity.

Lumbosacral Spine Radiography Examination Specifications (Children)

- Standard examination includes AP and lateral views. Collimation to reduce exposure to lateral-peripheral soft tissues in the abdomen to reduce radiation exposure and scatter formation should be present. A PA view may be used to reduce radiation dose.
- Oblique views are generally not recommended because of the added radiation and low diagnostic yield. A special dispensation for evaluation of acute pars interarticularis fractures should be considered as a useful indication for lumbar spine oblique projections in children.
- Additional evaluation may be obtained for specific clinical indications.

Examination of Neonates and Infants

- Usually evaluated with ultrasound (see the ACR–AIUM–SPR–SRU Practice Parameter for the Performance of an Ultrasound Examination of the Neonatal and

Infant Spine) or MRI if congenital abnormality or trauma is highly suspected clinically or based on other imaging.

- Interpretation of cervical spine radiography is difficult in infants because of epiphyseal variants, incomplete ossification of synchondroses including the apex of the odontoid, normal ligamentous laxity resulting in pseudosubluxation of C2 on C3, and the propensity of ligamentous rather than osseous injury. Normal lack of ossification of the anterior arch of C1 precludes radiographic evaluation of the atlantodental interval. MRI should be considered if there is concern for cervical spine injury.
- Frontal and lateral views of the cervical spine, and combined frontal and lateral views of the thoracic and lumbar spine may be performed. These views are most frequently used in the setting of a skeletal survey for nonaccidental trauma or in the evaluation of skeletal dysplasia or congenital vertebral anomalies.

4.2.6 Comparative, Post-Treatment, and/or X-Rays to Monitor Patient Progress

Follow-up studies and/or exit films are not necessary unless specific indications are observed. The practitioner must have a clear clinical rationale to explain the benefit and necessity of the repeat radiographic series considering the known health risks associated with the additional radiation exposure. Indications may include monitoring healing of a fracture, monitoring aggressive bone/joint diseases (e.g., various inflammatory arthritic disorders), or a potentially progressive idiopathic scoliosis. In the absence of clinical progression, scoliosis radiography examinations are not needed on a scoliosis patient, who has not reached skeletal maturity and is supported by examination, more frequently than once a year. However, when the risk of progression is highest (e.g., during puberty), more frequent imaging may be needed, but not more than every six months. If prior imaging has been performed at another facility for a patient presenting with a condition including indicators for imaging, then all reasonable attempts must be made to obtain the results of those studies prior to repeating the study.

The association between cervical lordosis (sagittal alignment) and neck pain is controversial. Further, it is unclear whether spinal manipulative therapy can change cervical lordosis. Shilton et al. (2015), found no difference in cervical lordosis (sagittal alignment) between patients with mild non-specific neck pain and matched healthy volunteers. Furthermore, there was no significant change in cervical lordosis in patients after 4 weeks of cervical spinal manipulation. Frauenfelder et al. (2007), concluded that the presence of such structural abnormalities (global cervical curvature or segmental angles) in the patient with neck pain must be considered coincidental, i.e., not necessarily indicative of the cause of pain.

4.2.7 Skeletal and Joint Surveys

A skeletal survey is a systematically performed series of radiographic images that

encompasses the entire skeleton or those anatomic regions appropriate for the clinical indications. Radiographic skeletal surveys are used for a variety of clinical problems in infants and children. The goal of the skeletal survey is to accurately identify focal and diffuse abnormalities of the skeleton, including acute or healing fractures, bone lesions, evidence of metabolic bone disease, or characteristics of skeletal dysplasia, and to differentiate them from developmental changes and other anatomic variants that may occur in infants and children.

According to the American College of Radiology, skeletal surveys are primarily used for (but not exclusively) to evaluate:

1. Known or suspected physical abuse in infants and young children
2. Known or suspected skeletal dysplasias, syndromes, and metabolic disorders
3. Known or suspected neoplasia and related disorders

For additional information regarding Skeletal Surveys (e.g., Specification of the Examination), go to ACR–SPR Practice Parameter for the Performance and Interpretation of Skeletal Surveys in Children (Revised 2021 -Resolution 37) at https://www.acr.org/-/media/ACR/Files/Practice-Parameters/Skeletal-Survey.pdf.

Radiographic joint surveys should be limited to scenarios where there is clinical suspicion for polyarticular arthropathies or conditions that have a high probability to affect multiple joints (e.g., rheumatoid arthritis, psoriatic arthritis, hemophilia, sickle cell anemia) as a method of establishing baseline joint changes. It should be noted that the sensitivity for radiographs to detect early joint changes such as synovitis or even subchondral erosions is poor compared to other imaging modalities such as ultrasound or MRI and these would be the preferred modalities of evaluation if available.

4.2.8 Chest Radiography

Chest radiography is a proven and useful imaging tool in the evaluation of the airways, lungs, pulmonary vessels, mediastinum, heart, pleura, and chest wall. The routine and accepted practice consists of posteroanterior (PA) and left lateral radiographic images obtained in the upright position.

A standard chest examination should include an erect PA and left lateral projection made during full inspiration. The examination may be modified by the physician or qualified technologist depending on the clinical circumstances. In some instances, additional views may be clinically useful. Decubitus views can aid in detecting pneumothoraces and establishing mobile versus loculated pleural effusions. Reverse apical lordotic and oblique views help in localizing abnormalities to the lung or bones. Views in expiration or bilateral

decubitus views may also be useful in the assessment of air trapping, such as in the setting of radiolucent endobronchial foreign bodies in pediatric patients. Expiration views have limited utility in the detection of pneumothorax. Radiograph with nipple markers can be helpful in evaluating nodular opacities in the expected location of the nipple. At times, as in the case of a pregnant or pediatric patient, a single frontal view may be appropriate. In young pediatric patients who are not able to stand for appropriate positioning, supine or sitting anteroposterior (AP) radiographs are routinely performed. Cross-table lateral radiographs may be done with the patient supine and the arms raised above the head, which facilitates proper positioning. In adults unable to stand or known to be at risk for a fall, a sitting AP view may be substituted for a PA view.

The goals of the chest radiographic examination are to help identify or exclude disease processes that may involve the thorax, determine the etiology of symptoms, and potentially follow its course.

According to the American College of Radiology, indications for chest radiography include but are not limited to:

- Evaluation of signs and symptoms potentially related to the respiratory, cardiovascular, upper gastrointestinal, and thoracic musculoskeletal systems. The chest radiograph may also help to evaluate disease processes, including systemic and extra thoracic diseases that secondarily involve the chest. Because the lungs and bony thorax are frequent sites of metastases, chest radiography may be useful in staging neoplasms. However, chest radiography should not replace chest CT (computed tomography) as part of routine restaging or when there is clinical suspicion for disease recurrence or progression.
- Follow-up of known thoracic disease processes when clinically indicated. Routine chest radiographs are not necessary in children to ensure resolution, such as in uncomplicated pneumonia.
- Monitoring patients with life-support devices and patients who have undergone cardiac or thoracic surgery or other interventional procedures. A clinical restricted approach should limit daily chest radiographs in those patients who have not had clinical change or movement in their support devices.
- Compliance with government regulations that may mandate chest radiography. Examples include surveillance PA chest radiographs for active tuberculosis or occupational lung disease or exposures, or other surveillance studies required by public health law.
- Preoperative radiographic evaluation when cardiac or respiratory symptoms are present and there is a significant potential for thoracic pathology that may influence anesthesia or the surgical result or lead to increased perioperative morbidity or mortality. Routine preoperative chest X-rays are not appropriate.

For additional information (e.g., Specification of the Examination) regarding Chest Radiography, go to ACR–SPR–STR Practice Parameter for The Performance Of Chest Radiography (Revised 2022 -Resolution 11) at https://www.acr.org/-/media/ACR/Files/Practice-Parameters/ChestRad.pdf.

4.2.9 Consultation on X-Ray examination made elsewhere, written report (CPT® Code 76140)

Consultation on X-ray examination made elsewhere, written report (CPT® Code 76140) MUST be initiated by another physician (not the patient), or an appropriate source as defined by CPT® guidelines (e.g., healthcare agency, attorney, insurance company, other healthcare provider). This service code is typically utilized by a radiologist or other provider of higher qualification than the primary interpretation and is initiated because of uncertainty of the primary evaluator.

The consultation request is **not** billable as a separate service by a treating health care provider. The medical decision making (MDM) component of an E/M service includes ordering and/or reviewing of data, which includes a review and interpretation of medical records and reports (e.g., X-ray, lab, etc.). Even if the images are taken in another facility, the work involved in reviewing the radiograph itself along with any reports is considered bundled into the MDM portion of the E/M service and is not separately payable.

If a patient presents to an office for a new patient visit and brings to the practitioner (e.g., physician, chiropractor) his or her medical records, including radiographs, the practitioner should **not** report CPT® Code 76140. Although the radiographs may have been taken elsewhere, the practitioner does not perform a consultation as intended by CPT® Code 76140. Rather, the review or re-read of the radiographs would be considered part of the face-to-face E/M service provided to the patient. The E/M codes include work done before, during, or after the E/M visit. Review of radiographs is part of the E/M service. CPT® Code 76140 represents a consultation, in which a radiologist or other consultant only renders an opinion or gives advice regarding the film in the form of a written report. In general, when reporting CPT® Code 76140, the consultant is not concurrently providing an E/M face-to-face service to the patient.

5. APPENDIX A: QUALITY INDICATORS RELATED TO IMAGING FOR LOW BACK PAIN (ADULTS AGED 18-75)

National and regional health plans are collecting Healthcare Effectiveness Data and Information Set (HEDIS) quality measures in support of their quality improvement initiatives and their National Committee for Quality Assurance (NCQA) accreditation. Low back pain imaging is one of the measures HEDIS uses to assess appropriateness of patient management and treatment. NCQA/HEDIS implemented this measure to identify

unnecessary imaging of patients where the clinical evaluation does not support the medical necessity of lumbar spine plain radiography.

Chiropractic and Medical providers may be flagged on audit for unnecessary low back radiographs when a claim is submitted, and the claim does not document the medical necessity of the radiology service. If a claim is submitted with any of the 85-triggering low back pain (LBP) inclusive diagnosis codes as a primary diagnosis code, and a qualified excluding diagnosis code is not added, the claim can be flagged during an audit as not meeting the quality measure.

Some examples from the HEDIS list of 85 LBP triggering ICD-10 codes include:

- M54.16 Radiculopathy lumbar region
- M54.30 Sciatica, unspecified site
- M54.50 LBP, unspecified
- M54.51 Vertebrogenic back pain
- M54.59 Other low back pain

Some examples of Qualified Exclusion codes include:

- G89.11 Acute pain due to trauma
- R26.2 Difficulty walking
- R29.2 Abnormal reflex

There are thousands of conditions and services that fall under the qualified exclusionary code set:

- Cancer – active now or personal history of cancer any time during member's lifetime
- Recent Trauma and/or Fragility Fracture – anytime 90 days prior to diagnosis
- Inflammatory arthritis
- Neurologic impairment – any time during 12 months prior to the diagnosis
- Spinal Infection – any time during 12 months prior to diagnosis.
- Lumbar Surgery and/or Spondylopathy – any time during members history
- Osteoporosis – osteoporosis therapy or prescriptions to treat osteoporosis any time during the members history.
- Prolonged Use of Corticosteroids – 90 consecutive days of corticosteroid treatment during a 365-day time period.
- Intravenous drug abuse – IV Drug use any time during 12 months prior to diagnosis
- HIV and/or Major Organ transplant – any time during the members history
- Palliative care or hospice services – any time during the measurement year

While healthcare practitioners generally document past-history and/or concurrent conditions or complications within their medical records, it is not as routine to document these on submitted claims. Because claims data is frequently used to evaluate quality measures, practitioners should remember to include, when appropriate and applicable for the patient, a qualified exclusionary ICD-10 code on the submitted claim. Some patients may have multiple exclusionary diagnosis codes. If there is documentation of a qualified exclusionary code validating the medical necessity to perform imaging, the radiology service would not be included in the HEDIS calculation, and a practitioner can avoid triggering a claims audit.

In summary, if the claim documents any of the 85 LBP triggering ICD-10 Codes from the HEDIS value set as a primary diagnosis, then the practitioner can keep the primary LBP diagnosis and add to the claim the clinically documented qualified exclusion code(s) such as cancer codes appropriate for that patient. In addition to the HEDIS measures, any X-ray code(s) used on the claim form must be supported by the documentation in the patient's medical record and meet medical necessity criteria as outlined in this Clinical Practice Guideline.

Discover additional information regarding HEDIS Measures and Technical Resources at:

- https://www.ncqa.org/hedis/measures/
- https://www.ncqa.org/hedis/measures/use-of-imaging-studies-for-low-back-pain/

References

Abumi, K., Fujiya, M., Saita, M., & Kaneda, K. (1998). Occipitoatlantal instability associated with articular tropism. *European Spine Journal, 7*(1), 76-79.

Allmann, K. H., Uhl, M., Uhrmeister, P., Neumann, K., von Kempis, J., & Langer, M. (1998). Functional MR imaging of the cervical spine in patients with rheumatoid arthritis. *Acta Radiologica, 39*(5), 543-546.

American Academy of Orthopaedic Surgeons. Limb Length Discrepancy. Retrieved July 16. 2024 from http://orthoinfo.aaos.org/topic.cfm?topic=a00259

American Association of Neurological Surgeons (AANS). (n.d.) Scoliosis. Retrieved July 16, 2024 from https://www.aans.org/en/Patients/Neurosurgical-Conditions-and-Treatments/Scoliosis

American College of Radiology. (2022). ACR-ASSR-SPR-SSR practice guideline for the performance of spine radiology (Resolution 37). Retrieved July 16, 2024 from https://www.acr.org/-/media/ACR/Files/Practice-Parameters/Rad-Spine.pdf

American College of Radiology (2021). ACR-SPR practice parameters for the performance and interpretation of skeletal surveys in children (Resolution 37). Retrieved on July 16, 2024 from https://www.acr.org/-/media/ACR/Files/Practice-Parameters/Skeletal-Survey.pdf

American College of Radiology. (2019). ACR–SPR–SSR practice parameter for the performance of radiography for scoliosis in children. Retrieved on July 16, 2024 from https://www.acr.org/-/media/ACR/Files/Practice-Parameters/Scoliosis.pdf

American College of Radiology (2023). ACR–SPR–SSR practice parameter for the performance of radiography of the extremities (Resolution 16). Retrieved on July 16, 2024 from https://www.acr.org/-/media/ACR/Files/Practice-Parameters/Rad-Extremity.pdf

American College of Radiology. (2022). ACR-SPR-STR practice parameter for the performance of chest radiography (Resolution 11). Retrieved on July 16, 2024 from https://www.acr.org/-/media/ACR/Files/Practice-Parameters/ChestRad.pdf

American Medical Association. (current year). Current Procedural Terminology (CPT) current year. Chicago: AMA.

Ammendolia, C., Bombardier, C. Hogg-Johnson, S., & Glazier, R. (2002). Views on radiography use for patients with acute low back pain among chiropractors in an Ontario community. *Journal of Manipulative and Physiological Therapeutics, 25*(8), 517-518.

Ammendolia, C., Hogg-Johnson, S., Pennick, V., Glazier, R., & Bombardier, C., (2004). Implementing Evidence-Based Guidelines for Radiography in Acute Low Back Pain: A Pilot Study in a Chiropractic Community. *Journal of Manipulative and Physiological Therapeutics, 27*(3), 170-179.

Andersen JC. Is immediate imaging important in managing low back pain? J Athl Train. 2011 Jan-Feb;46(1):99-102.

Azar FM, Beaty JH, Daugherty K, Jones L, Campbell, WC (Ed.). *Campbell's operative orthopaedics* (14th ed.). Elsevier; 2020.

Bandiera, G., Stiell, I. G., Wells, G. A., Clement, C., DeMaio, V., et al. (2003). The Canadian C-Spine rule performs better than unstructured physician judgment. *Annals of Emergency Medicine 42*(3), 395-402.

Berrington de Gonzalez, A., Darby, S. (2004). Risk of cancer from diagnostic X-rays: Estimates for the UK and 14 other countries. The Lancet, 363, 345-35

Berrington de González A, Mahesh M, Kim KP, Bhargavan M, Lewis R, Mettler F, Land C. Projected cancer risks from computed tomographic scans performed in the United States in 2007. Arch Intern Med. 2009 Dec 14;169(22):2071-7.

Bussières, A. Diagnostic Imaging Practice Guidelines for Musculoskeletal Complaints in Adults—An Evidence-Based Approach—Part 3: Spinal Disorders. *Journal of Manipulative Physiological Therapies 31*, 33-88

Bussières, A., Ammendolia, C., Peterson, C., Taylor, J. (2006). Ionizing radiation exposure – more good than harm? The preponderance of evidence does not support abandoning current standards and regulations. *Journal of the Canadian Chiropractic Association 50*(2), 103-106

Bussières, A., Peterson, C., Taylor, J. (2008). Diagnostic Imaging Guideline for Adults. Part 2: Upper Extremity Disorders - An Evidence-based Approach. *Journal of Manipulative Physiological Therapy 31*, 2-32.

Bussieres, A., Peterson, C., & Taylor, J (2007). Diagnostic Imaging Practice Guidelines for Musculoskeletal Complaints in Adults – An Evidence-Based Approach: Introduction. *Journal of Manipulative and Physiological Therapeutics, 30*(9), 617-683.

Bussières, A., Taylor, J., Peterson, C. (2007). Diagnostic Imaging Practice Guidelines for Musculoskeletal Complaints in Adults - An Evidence-based Approach: Part 1: Lower Extremity Disorders. *Journal of Manipulative Physiological Therapy 30*(9), 684-717.

Bussières AE, Sales AE, Ramsay T, Hilles S, Grimshaw JM. Practice patterns in spine radiograph utilization among Doctor of Chiropractic enrolled in a provider network offering complementary care in the United States. J Manipulative Physiol Ther. 2013 Mar-Apr;36(3):127-42.

Campbell, S. E., Phillips, C. D., Dubovsky, E., Cail, W. S., & Omary, R. A. (1995). The value of CT in determining potential instability of simple wedge-compression fractures of the lumbar spine. *American Journal of Neuroradiology, 16*(7), 1385-1392.

Casiano VE, Dydyk AM, Varacallo M. Back Pain. In: StatPearls. Treasure Island (FL): StatPearls Publishing; July 18, 2021.

Chang, H., Park, J. B., Kim, K. W., & Choi, W. S. (2000). Retro-dental reactive lesions related to development of myelopathy in patients with atlantoaxial instability secondary to Os odontoideum. *Spine, 25*(21), 2777-2783.

Cheung TC, Tank Y, Breederveld RS et-al. Diagnostic accuracy and reproducibility of the Ottawa Knee Rule vs the Pittsburgh Decision Rule. Am J Emerg Med. 2013;31 (4): 641-5.

Chiu, W. C., Haan, J. M., Cushing, B. M., Kramer, M. E., & Scalea, T. M. (2001). Ligamentous injuries of the cervical spine in unreliable blunt trauma patients: Incidence, evaluation, and outcome. *Journal of Trauma, 50*(3), 457-463; discussion, 464.

Chodick G, Ronckers CM, Shalev V, Ron E. Excess lifetime cancer mortality risk attributable to radiation exposure from computed tomography examinations in children. Isr Med Assoc J. 2007 Aug;9(8):584-7.

Choosing Wisely. Imaging for low back pain. AAFP. Published 2018. Accessed July 16, 2024. https://www.aafp.org/family-physician/patient-care/clinical-recommendations/all-clinical-recommendations/cw-back-pain.html

Chou R, Qaseem A, Owens DK, Shekelle P, for the Clinical Guidelines Committee of the American College of Physicians. Diagnostic Imaging for Low Back Pain: Advice for High-Value Health Care From the American College of Physicians. Ann Intern Med. 2011;154:181–189.

Corso M, Cancelliere C, Mior S, Kumar V, Smith A, Côté P. The clinical utility of routine spinal radiographs by chiropractors: a rapid review of the literature. *Chiropr Man Therap*. 2020;28(1):33. Published 2020 Jul 9. doi:10.1186/s12998-020-00323-8

Daffner, R. H., Brown, R. R., & Goldberg, A. L. (2000). A new classification for cervical vertebral injuries: Influence of CT. *Skeletal Radiology, 29*(3), 125-132.

Dagenais S, Haldeman S. Evidence-based management of low back pain. Mosby (Elsevier) 2012; Chapter 3:21-31

Deyo, R., & Weinstein, J. N. (2001). Low back pain. *New England Journal of Medicine, 344*(5).

Dowling S, Spooner CH, Liang Y, et al. (April 2009). "Accuracy of Ottawa Ankle Rules to exclude fractures of the ankle and midfoot in children: a meta-analysis". Acad Emerg Med. 16 (4): 277–87.

Dvorak, J., Panjabi, M. M., Novotny, J. E., Chang, D. G., & Grob, D. (1991). Clinical validation of functional flexion-extension roentgenograms of the lumbar spine. *Spine, 16*(8), 943-950.

Expert Panel on Neurological Imaging, Hutchins TA, Peckham M, et al. ACR Appropriateness Criteria® Low Back Pain: 2021 Update. J Am Coll Radiol. 2021;18(11S):S361-S379.

Gatterman, B. (1990.) Guidelines in the use of radiology in chiropractic. *Dynamic Chiropractic, 8*(12). Retrieved November 16, 2023, from http://www.chiroweb.com/archives/08/12/01.html

Goertz M, Thorson D, Bonsell J, et al. Institute for Clinical Systems Improvement. Adult acute and subacute low back pain. Updated November 2012. Accessed March 18, 2013.

Greene, K. A., Dickman, C. A., Marciano, F. F., Drabier, J. B., Hadley, M. N., & Sonntag, V. K. (1997). Acute axis fractures. Analysis of management and outcome in 340 consecutive cases. *Spine, 22*(16), 1843-1852.

Grob D, Frauenfelder H, Mannion AF. Eur Spine J. 2007 May;16(5):669-78. Epub 2006 Nov 18.

Haas, M., Nyiendo, J., Peterson, C., Thiel, H., Sellers, T., Cassidy, D., et al. (1990). Interrater reliability of roentgenological evaluation of the lumbar spine in lateral bending. *Journal of Manipulative and Physiological Therapeutics, 13*(4), 179-189.

Halliday, A. L., Henderson, B. R., Hart, B. L., & Benzel, E. C. (1997). The management of unilateral lateral mass/facet fractures of the sub axial cervical spine: The use of magnetic resonance imaging to predict instability. *Spine, 22*(22), 2614-2621.

Harris, M. B., Waguespack, A. M., & Kronlage, S. (1997). 'Clearing' cervical spine injuries in polytrauma patients: Is it really safe to remove the collar? *Orthopedics, 20*(10), 903-907.

Hawley C, Rosenblatt R. Ottowa and Pittsburgh rules for acute knee injuries. The Journal of Family Practice 1998;47(4):254-255.

Health Risks from Exposure to Low Levels of Ionizing Radiation: BEIR VII – Phase 2 Committee to Assess Health Risks from Exposure to Low Levels of Ionizing Radiation. National Research Council. Copyright 2015 by the National Academy of Sciences

Hall A M, Aubrey-Bassler K, Thorne B, Maher C G. Do not routinely offer imaging for uncomplicated low back pain *BMJ* 2021; 372 :n291 doi:10.1136/bmj.n291

Hoffman, J. R., Mower, W. R., Wolfson, A. B., Todd, K. H., Zucker, M. I. (2000) Validity of a set of clinical criteria to rule out injury to the cervical spine in patients with blunch trauma. *New England Journal of Medicine343*(2), 94-100.

Holmberg O, Malone J, Rehani M, McLean D, Czarwinski R. Current issues and actions in radiation protection of patients. Eur J Radiol. 2010 Oct;76(1):15-9.

Jenkins HJ, Downie AS, Moore CS, French SD. Current evidence for spinal X-ray use in the chiropractic profession: a narrative review. *Chiropr Man Therap*. 2018;26:48. Published 2018 Nov 21. doi:10.1186/s12998-018-0217-8

Jenkins HJ, Kongsted A, French SD, et al. What are the effects of diagnostic imaging on clinical outcomes in patients with low back pain presenting for chiropractic care: a matched observational study. Chiropr Man Therap. 2021;29(1):46. Published 2021 Nov 23. -3

Junge, A., Krueger, A., Petermann, J., & Gotzen, L. (2001). Posterior atlanto-occipital dislocation and concomitant discoligamentous C3-C4 instability with survival. *Spine, 26*(15), 1722-1725.

Konan S, Zang TT, Tamimi N, Haddad FS. Can the Ottawa and Pittsburgh rules reduce requests for radiography in patients referred to acute knee clinics? Ann R Coll Surg Engl. 2013 Apr;95(3):188-91.

Lew M, Snow GJ. Radiograph utilization and demographics in a chiropractic college teaching clinic. J Chiropr Med. 2012 Dec;11(4):242-8.

Linet MS, Slovis TL, Miller DL, et al. Cancer risks associated with external radiation from diagnostic imaging procedures [published correction appears in CA Cancer J Clin. 2012 Jul-Aug;62(4):277]. CA Cancer J Clin. 2012;62(2):75-100. doi:10.3322/caac.21132

Lusted, L. B. (1997). *A study of the efficacy of diagnostic radiological procedures.* Chicago: American College of Radiology.

Marquart, D. J. (1990, June). *Cervical spine imaging: Uses and guidelines.* Transactions of the Consortium for Chiropractic Research; Proceedings of the Fifth Annual Conference on Research and Education.

Mercy Center Consensus Conference, (1992: Burlingame, California). Haldeman, S. (Ed.), Chapman-Smith, D. (Ed.), & Peterson, D. M (Ed.). *Guidelines for chiropractic quality assurance and practice parameters: Proceeding of the Mercy Center Consensus Conference.* Gaithersburg, MD: Aspen Publications.

Meyers, L. L., Dobson, S. R., Wiegand, D., Webb, J. D., & Mencio, G. A. (1999). Mechanical instability as a cause of gait disturbance in high-grade spondylolisthesis: A pre- and postoperative three-dimensional gait analysis. *Journal of Pediatric Orthopedics, 19*(5), 672-676.

Mootz, R. D., & Hansen, D. T. (1999). *Chiropractic technologies*. Gaithersburg, MD: Aspen Publications.

Mootz, R. D., Hansen, D. T., & Hoffman, L. E. (1997). *Topics in clinical chiropractic.* Gaithersburg, MD: Aspen Publications.

Murphy, A. (2023). Knee (AP weight-bearing view). Reference article, Radiopaedia.org. Retrieved on July 16, 2024 from https://radiopaedia.org/articles/48353 .

Murray, K. J., & Azari, M. F. (2015). Leg length discrepancy and osteoarthritis in the knee, hip and lumbar spine. *The Journal of the Canadian Chiropractic Association, 59*(3), 226-237.

National Committee for Quality Assurance (NCQA). (n.d.) Use of Imaging Studies for Low Back Pain (LBP). Retrieved July 16, 2024 from U Use of Imaging Studies for Low Back Pain – NCQA

Ottawa rules for x-ray of the knee, ankle and foot. (n.d.). Retrieved July 16, 2024, from https://www.med.unc.edu/emergmed/files/2018/06/Ottawa-rules-for-x-ray.pdf

Pearce MS, Salotti JA, Little MP, McHugh K, Lee C, Kim KP, et al. Radiation exposure from CT scans in childhood and subsequent risk of leukaemia and brain tumours: a retrospective cohort study. Lancet. 2012. Epub 2012/06/12.

Phillips, R. B., Howe, J. W., Bustin, G., Mick, T. J., Rosenfeld, I., & Mills, T. (1990). Stress x-rays and the low back pain patient. *Journal of Manipulative and Physiological Therapeutics, 13*(23), 1127-1133.

Physiopedia. (n.d). Ottawa Ankle Rules. Retrieved on July 16, 2024 from https://www.physio-pedia.com/Ottawa_Ankle_Rules

Ratliff, J., & Voorhies, R. (2000). Increased MRI signal intensity in association with myelopathy and cervical instability: Case report and review of the literature. *Surgical Neurology, 53*(1), 8-13.

Rubinstein SM, van Tulder M. A best-evidence review of diagnostic procedures for neck and low-back pain. Best Pract Res Clin Rheumatol. 2008 Jun;22(3):471-82.

Sabharwal, S., & Kumar, A. (2008). Methods for Assessing Leg Length Discrepancy. *Clinical Orthopaedics and Related Research, 466*(12), 2910-2922. doi: 10.1007/s11999-008-0524-9

Sanhudo, J. A., & Gomes, J. L. (2014). Association between leg length discrepancy and posterior tibial tendon dysfunction. *Foot Ankle Spec, 7*(2), 119-126. doi: 10.1177/1938640014522096

Shailam, R., Jaramillo, D., & Kan, J. H. (2013). Growth arrest and leg-length discrepancy. *Pediatr Radiol, 43 Suppl 1,* S155-165. doi: 10.1007/s00247-012-2598-5

Shilton M, Branney J, de Vries BP, Breen AC. Does cervical lordosis change after spinal manipulation for non-specific neck pain? A prospective cohort study. Chiropr Man Therap. 2015;23:33. Published 2015 Dec 7. doi:10.1186/s12998-015-0078-3

Shraim BA, Shraim MA, Ibrahim AR, Elgamal ME, Al-Omari B, Shraim M. The association between early MRI and length of disability in acute lower back pain: a systematic review and narrative synthesis. BMC Musculoskelet Disord. 2021;22(1):983.

Sierink JC, van Lieshout WA, Beenen LF, Schep NW, Vandertop WP, Goslings JC. Systematic review of flexion/extension radiography of the cervical spine in trauma patients. Eur J Radiol. 2013 Jun;82(6):974-81.

Simmons, E. D., Jr., Guyer, R. D., Graham-Smith, A., & Herzog, R. (1995). Radiographic assessment for patients with low back pain. *Spine, 20*(16), 1839-1841.

Skinner, H. B. (Ed.). (2000). Current diagnosis and treatment in orthopedics (2nd ed.). New York: Lange Medical Books/McGraw-Hill.

Staiger, T. O., Paauw, D. S., Deyo, R. A., & Jarvik, J. G. (1999). Imaging studies for acute low back pain: When and when not to order them. *Postgraduate Medicine, 105*(4).

Stiell I G, Wells, GA, Hoag, RH, et al. Implementation of the Ottawa Knee Rule for the Use of Radiography in Acute Knee Injuries JAMA. 1997; 278(23): 2075-2079.

Stiell IG, Clement CM, Grimshaw J, Brison R, Rowe BH, Schull MJ, Lee J, Brehaut J, McKnight D, Eisenhauer MA, Dreyer J, Letovsky E, Rutledge T, MacPhail I, Ross S, Perry JJ, Holroyd BR, Ip U, Lesiuk H, Wells GA. Implementation of the Canadian C-Spine Rule: A Prospective 12-Centre Cluster Randomized Trial. British Medical Journal 2009. BMJ. 2009 Oct 29;339:b4146.

Stiell, I. G., Wells, G. A., Vandemheen, K. L., Clement, C., DeMaio, V., et al. (2001) The Canadian C-Spine rule for radiography in alert and stable trauma patients. *Journal of the American Medical Association, 286*(15), 1841-1848.

Taylor, J. A. M., & Resnick, D. (1995). Imaging decisions in the management of low back pain. In D. J. Lawrence (Ed.), *Advances in Chiropractic*. St. Louis, MO: Mosby Year-Book.

Taylor, J. A. M., & Resnick, D. (2000). Skeletal imaging: Atlas of the spine and extremities. Philadelphia: W.B. Saunders.

Taylor JA, Bussières A. Diagnostic imaging for spinal disorders in the elderly: a narrative review. Chiropr Man Therap. 2012 May 24;20(1):16.

Teo, E. C., & Ng, H. W. (2000). Analytical static stress analysis of first cervical vertebra (atlas). *Annals of the Academy of Medicine, Singapore, 29*(4), 503-509.

Terry, M. A., Winell, J. J., Green, D. W., Schneider, R., Peterson, M., Marx, R. G., & Widmann, R. F. (2005). Measurement Variance in Limb Length Discrepancy: Clinical and Radiographic Assessment of Interobserver and Intraobserver Variability. *Journal of Pediatric Orthopaedics, 25*(2), 197-201. doi: 10.1097/01.bpo.0000148496.97556.9f

Truumees, E., & Herkowitz, H. N. (2000). Cervical spondylotic myelopathy and radiculopathy. *Instructional Course Lectures, 49,* 339-360.

Tuite, G. F., Veres, R., Crockard, H. A., Peterson, D., & Hayward, R. D. (1996). Use of an adjustable, transportable, radiolucent spinal immobilization device in the comprehensive management of cervical spine instability. Technical note. *Journal of Neurosurgery, 85*(6), 1177-1180.

Van Gerven P, Rubinstein SM, Nederpelt C, Termaat MF, Krijnen P, van Tulder MW, Schipper IB. The value of radiography in the follow-up of extremity fractures: a systematic review. Arch Orthop Trauma Surg. 2018 Dec;138(12):1659-1669.

Vitzthum, H. E., Konig, A., & Seifert, V. (2000). Dynamic examination of the lumbar spine by using vertical, open magnetic resonance imaging. *Journal of Neurosurgery, 93*(1 Suppl), 58-64.

Waddell, G. (2004). *The back pain revolution.* London: Churchill Livingstone.

Wiles LK, Hibbert PD, Stephens JH, et al. What Constitutes "Appropriate Care" for Low Back Pain?: Point-of-Care Clinical Indicators From Guideline Evidence and Experts (the STANDING Collaboration Project) [published online ahead of print, 2021 Nov 17]. Spine (Phila Pa 1976). 2021;10.1097/BRS.0000000000004274.

Williams, R. L., Hardman, J. A., & Lyons, K. (1998). MR imaging of suspected acute spinal instability. *Injury, 29*(2), 109-113.

Yochum, T. R., & Rowe, L. J. (2005). *Essentials of skeletal radiology* (3rd ed.). Baltimore: Williams & Wilkins.