ACR–ASNR–ASSR–SIR–SNIS PRACTICE PARAMETER FOR THE PERFORMANCE OF IMAGE-GUIDED EPIDURAL STEROID INJECTION

The American College of Radiology, with more than 40,000 members, is the principal organization of radiologists, radiation oncologists, and clinical medical physicists in the United States. The College is a nonprofit professional society whose primary purposes are to advance the science of radiology, improve radiologic services to the patient, study the socioeconomic aspects of the practice of radiology, and encourage continuing education for radiologists, radiation oncologists, medical physicists, and persons practicing in allied professional fields.

The American College of Radiology will periodically define new practice parameters and technical standards for radiologic practice to help advance the science of radiology and to improve the quality of service to patients throughout the United States. Existing practice parameters and technical standards will be reviewed for revision or renewal, as appropriate, on their fifth anniversary or sooner, if indicated.

Each practice parameter and technical standard, representing a policy statement by the College, has undergone a thorough consensus process in which it has been subjected to extensive review and approval. The practice parameters and technical standards recognize that the safe and effective use of diagnostic and therapeutic radiology requires specific training, skills, and techniques, as described in each document. Reproduction or modification of the published practice parameter and technical standard by those entities not providing these services is not authorized.

PREAMBLE

This document is an educational tool designed to assist practitioners in providing appropriate radiologic care for patients. Practice Parameters and Technical Standards are not inflexible rules or requirements of practice and are not intended, nor should they be used, to establish a legal standard of care[1]. For these reasons and those set forth below, the American College of Radiology and our collaborating medical specialty societies caution against the use of these documents in litigation in which the clinical decisions of a practitioner are called into question.

The ultimate judgment regarding the propriety of any specific procedure or course of action must be made by the practitioner considering all the circumstances presented. Thus, an approach that differs from the guidance in this document, standing alone, does not necessarily imply that the approach was below the standard of care. To the contrary, a conscientious practitioner may responsibly adopt a course of action different from that set forth in this document when, in the reasonable judgment of the practitioner, such course of action is indicated by variables such as the condition of the patient, limitations of available resources, or advances in knowledge or technology after publication of this document. However, a practitioner who employs an approach substantially different from the guidance in this document may consider documenting in the patient record information sufficient to explain the approach taken.

The practice of medicine involves the science, and the art of dealing with the prevention, diagnosis, alleviation, and treatment of disease. The variety and complexity of human conditions make it impossible to always reach the most appropriate diagnosis or to predict with certainty a particular response to treatment. Therefore, it should be recognized that adherence to the guidance in this document will not assure an accurate diagnosis or a successful outcome. All that should be expected is that the practitioner will follow a reasonable course of action based on current knowledge, available resources, and the needs of the patient to deliver effective and safe medical care. The purpose of this document is to assist practitioners in achieving this objective.

---

1 *Iowa Medical Society and Iowa Society of Anesthesiologists v. Iowa Board of Nursing, 831 N.W.2d 826 (Iowa 2013) Iowa Supreme Court refuses to find that the "ACR Technical Standard for Management of the Use of Radiation in Fluoroscopic Procedures (Revised 2008)" sets a national standard for who may perform fluoroscopic procedures in light of the standard's stated purpose that ACR standards are educational tools and not intended to establish a legal standard of care. See also, Stanley v. McCarver, 63 P.3d 1076 (Ariz. App. 2003) where in a concurring opinion the Court stated that "published standards or guidelines of specialty medical organizations are useful in determining the duty owed or the standard of care applicable in a given situation" even though ACR standards themselves do not establish the standard of care.*

I. INTRODUCTION

This practice parameter was developed collaboratively by the American College of Radiology (ACR), the American Society of Neuroradiology (ASNR), the American Society of Spine Radiology (ASSR), the Society of Interventional Radiology (SIR), and the Society of NeuroInterventional Surgery (SNIS).

I. INTRODUCTION

A. Scope

This document focuses on epidural steroid injections (ESI), which are commonly performed for the nonsurgical treatment of neck and low back pain (LBP) after other conservative and noninvasive treatments, such as physical therapy and oral medications, have failed [1, 2]. ESI includes 3 general approaches to the epidural space: interlaminar, transforaminal (TFESI), or caudal (caudal-ESI) [3]. Injections are for diagnostic as well as therapeutic benefit. When used for diagnosis and surgical planning, local anesthetic injection provides information regarding whether the target is or is not the pain generator [4]. Moderate to strong recommendations for the performance of ESI based on level of evidence is detailed in the American Society of Interventional Pain Physicians' (ASIPP) comprehensive evidence-based guidelines from 2021 and the World Federation of Neurosurgery spine committee recommendations from 2024 [2, 5]. The ASIPP publication additionally includes a discussion of topics such as utilization, expenditure, anatomical and pathophysiological considerations and pharmacological and harmful effects of the drugs and the procedures themselves. Additional societal statements as well as meta-analyses discuss the now strong evidence for the effectiveness of ESI, specifically for LBP and lumbar radiculopathy [6-9].

The U.S Food and Drug Administration (FDA) issued a warning on April 23, 2014, that "injection of corticosteroids into the epidural space of the spine may result in rare but serious adverse events, including loss of vision, stroke, paralysis, and death" [10]. In addition, a warning was added to the drug labels of injectable corticosteroids to describe these risks. In response to this, an expert working group with facilitation from the FDA Safe Use Initiative and representatives from leading specialty societies reviewed the existing scientific evidence and assembled consensus clinical considerations aimed at reducing the risk of severe neurologic complications [11]. Since then, many publications have documented technical methods to reduce risk and improve efficacy, particularly regarding anatomical considerations and imaging guidance and with an emphasis on fastidious technique, as well as including a discussion of ongoing controversies [4, 12] [13] [14]. With ESI, as with any invasive procedure, the optimal outcome for the patient is when the appropriate procedure is performed by qualified physicians with consideration of all risks and benefits.

I. INTRODUCTION

B. Overview

In the appropriate patient population, ESI can improve pain, mobility, function, and quality of life. Multifactorial degenerative changes, such as herniated intervertebral disc material, thickening of the ligamentum flavum and productive osteophyte formation along endplates and facet joints are the leading cause of neck pain and LBP. A disc herniation may cause spinal nerve compression and inflammation, resulting in radicular pain [15]. The mechanical compression may result in nerve root microcirculatory changes, leading to ischemia, venous congestion, and inflammatory changes around nerve roots [16, 17]. The ensuing intraneural edema and demyelination have been shown to be critical factors to produce pain in association with nerve root compression [17]. There may also be a chemical radiculitis [18]. Because an inflammatory reaction is recognized as at least partly responsible for the irritation of the spinal nerve, corticosteroids are logically part of the treatment armamentarium. The injected corticosteroids contribute to pain reduction by interrupting the synthesis of prostaglandins, blocking conduction of nociceptive C fibers, and controlling edema around the nerve root [19-23].

The efficacy of ESI is thought to be primarily due to the anti-inflammatory effect of the steroid. Preservative-free local anesthetic, often added to the steroid injectate, inhibits nerve excitation/conduction. Local anesthetics and steroids may interrupt abnormal pathophysiologic responses to chronic pain or the development of chronic pain [24-32]. The individual biology and psychological effects of pain clearly adds to the different patient outcomes [33]. Rehabilitation after injections can also play an additive positive role. Such is the reason that multidisciplinary teams are necessary for the best outcomes, and most of the literature supports such integrative medicine.

I. INTRODUCTION

C. Definitions

Definitions and descriptions of epidural steroid approaches are described in Appendix A.

II. INDICATIONS AND CONTRAINDICATIONS

A. Indications include, but are not limited to, the following:

1. Radiculopathy and radicular pain: radiculopathy is a complex of symptoms that can arise from nerve root pathology, including paresthesia, hypoesthesia, anesthesia, loss of motor strength, and pain [34], and has specific physical examination and electrophysiologic findings. Radiculopathy may be confined to a single nerve root distribution (mono-) or more than one (poly-). Radicular pain refers to a single symptom of pain that can arise from one or more cervical, thoracic, or lumbar spinal nerve roots [34], which are inflamed and irritated [35], diagnosed by a combination of physical examinations (eg, straight leg test) and controlled selective nerve blocks. Radicular pain and radiculopathy that are due to nerve root compression from local malignancy may also be amendable to palliative treatment with ESI.
2. Spinal stenosis: mechanical pressure on the spinal cord, dura, or nerve roots from narrowing of the spinal canal which presents with gradual onset of pain, numbness, or upper- or lower-extremity weakness [9, 36].
3. Axial discogenic pain: symptoms exacerbated by forward flexion [37], nonradiating and diagnosed after exclusion of other sources of axial LBP such as the facet joint, the sacroiliac joint, paraspinal muscles, and fascia [5].
4. Postsurgery syndrome or failed back surgery syndrome: residual or recurrent back pain and disability after surgical intervention [5].
5. Persistent/incomplete pain relief following vertebral augmentation (kyphoplasty, vertebroplasty).

B. Contraindications

1. Coagulopathy not correctible
2. Concurrent systemic infection
3. Infectious spondylitis
4. Acute spinal cord compression
5. Myelopathy or cauda equina syndrome
6. Inability to obtain informed consent
7. Infection at the skin puncture site

C. Relative contraindications

1. Uncorrected anticoagulation therapy: ILESI and TFESI are considered intermediate-risk procedures with moderate risk of bleeding [38].
2. Hypersensitivity to administered agents: allergy to contrast may be treated with premedication with antihistamine agents or an alternative approach (such as using CT guidance with air as the contrast medium).
3. Pregnancy: although such interventions may be performed without image guidance in pregnant patients, there is a 30% rate of incorrect placement [39]. If clinically necessary, low-dose radiation techniques should be used when possible (including the use of pulsed fluoroscopy). Other options include MRI-guided injections and ultrasound (US)-guided injections because image-guided procedures have a significantly greater margin of safety and should be used when feasible [40].
4. Hepatitis: when performing neuraxial blockade in patients with hepatitis C, thrombocytopenia must be excluded to avoid hematoma formation and its associated neurologic complications [41].
5. Uncontrolled diabetes mellitus: insulin-dependent diabetics are at risk of elevated blood sugars after steroid injections.
6. Congestive heart failure: the steroid may lead to fluid retention.
7. Immunosuppressed state: preprocedural antibiotics may be considered.
8. Symptom improvement on medical and physical therapy.
9. Severe spinal canal stenosis.
10. No response to previous well-performed ESI.
11. Pre-existing complication of steroid therapy, eg, Cushing's disease.

III. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

A. Physician

In general, the requirements for physicians performing image-guided ESI may be met by adhering to the recommendations listed below:

1. Certification in Radiology, Diagnostic Radiology, or Interventional Radiology/Diagnostic Radiology (IR/DR) by the American Board of Radiology, the American Osteopathic Board of Radiology, the Royal College of Physicians and Surgeons of Canada or the Collège des Médecins du Québec and has performed (with supervision) enough ESI procedures to demonstrate competency as attested by the supervising physician(s).

   OR

2. Completion of an approved residency or fellowship program by the Accreditation Council for Graduate Medical Education (ACGME), the Royal College of Physicians and Surgeons of Canada, the Collège des Médecins du Québec, or an American Osteopathic Association (AOA)–approved residency program and has performed (with supervision) enough ESI procedures to demonstrate competency as attested by the supervising physician(s).

   OR

3. A physician who did not successfully complete an ACGME-approved radiology residency or fellowship program that included the above may still be considered qualified to perform ESI provided the following can be demonstrated: the physician must have at least 1 year of experience in performing percutaneous image-guided spine procedures, during which the physician was supervised by a physician with active privileges in these spine procedures. During this year, the physician must have performed (with supervision) enough image-guided spine interventional procedures, particularly ESI, as primary operator with outcomes within the quality improvement thresholds of this practice parameter.

   AND

4. Physicians meeting any of the qualifications in 1, 2, or 3 above must have written substantiation that they are familiar with all of the following:

   a. Indications and contraindications for ESI.
   b. Periprocedural and intraprocedural assessment, monitoring, and management of the patient, and particularly the recognition and initial management of procedural complications.
   c. Appropriate use and operation of fluoroscopic and radiographic equipment, digital subtraction systems, and other electronic imaging systems.
   d. Principles of radiation protection, hazards of radiation, and radiation monitoring requirements, as well as principles of "as low as reasonably achievable" (ALARA), as they apply to both patients and personnel.
   e. Anatomy, physiology, and pathophysiology of the spine, spinal cord, and nerve roots.
   f. Pharmacology of contrast agents and implanted materials and recognition and treatment of potential adverse reactions to these substances.
   g. Technical aspects of performing this procedure. These include proper sterile techniques.

   The written substantiation should come from the chief of interventional radiology, the chief of neuroradiology, the chief of musculoskeletal radiology, the chief of interventional neuroradiology, or the chair of the department of the institution in which the physician will be providing these services. At institutions in which there is joint (dual) credentialing across departments doing like procedures, this substantiation of experience should be done by the chairs of both departments to ensure equity of experience among practitioners when their training backgrounds differ. Substantiation could also come from a prior institution in which the physician provided the services, but only at the discretion of the current interventional, neurointerventional, or neuroradiology chief, or the chair who solicits the additional input.

   AND

5. Physicians must possess certain fundamental knowledge and skills that are required for the appropriate

application and safe performance of ESI:

a. In addition to a basic understanding of spinal anatomy, physiology, and pathophysiology, the physician must have sufficient knowledge of the clinical and imaging evaluation of patients with spinal disorders to determine those for whom ESIs are indicated.
b. The physician must fully appreciate the benefits and risks of epidural steroids and the alternatives to the procedure.
c. The physician is required to be competent in the use of fluoroscopy, CT, and MRI or interpretation of images in the modalities used to evaluate potential patients and guide the epidural steroid procedure.
d. The physician should be able to recognize, interpret, and act immediately on image findings.
e. The physician must have the ability, skill, and knowledge to evaluate the patient's clinical status and to identify those patients who might be at increased risk, who may require additional perioperative care, or who have relative contraindications to the procedure.
f. The physician must be capable of providing the initial clinical management of complications of ESI, including administration of basic life support and recognition of spinal cord compression.
g. Training in radiation physics and safety is an important component of these requirements. Such training is important to maximize both patient and physician safety. It is highly recommended that the physician has adequate training in and be familiar with the principles of radiation exposure, the hazards of radiation exposure to both patients and radiologic personnel, and the radiation monitoring requirements for the imaging methods listed above.

Maintenance of Competence

Physicians should perform a sufficient number of ESI procedures to maintain their skills, with acceptable success and complication rates as laid out in this practice parameter. Continued competence depends on participation in a quality improvement program that monitors these rates. Regular attendance at postgraduate courses that provide continuing education on diagnostic and technical advances in ESI is necessary.

Continuing Medical Education

The physician's continuing education should be in accordance with the ACR Practice Parameter for Continuing Medical Education (CME) [42].

III. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

B. Qualified Medical Physicist

A Qualified Medical Physicist is an individual who is competent to practice independently one or more of the subfields in medical physics. The American College of Radiology (ACR) considers certification, continuing education, and experience in the appropriate subfield(s) to demonstrate that an individual is competent to practice one or more of the subfields in medical physics and to be a Qualified Medical Physicist. The ACR strongly recommends that the individual be certified in the appropriate subfield(s) by the American Board of Radiology (ABR), the Canadian College of Physicists in Medicine (CCPM), the American Board of Science in Nuclear Medicine (ABSNM), or the American Board of Medical Physics (ABMP).

A Qualified Medical Physicist should meet the ACR Practice Parameter for Continuing Medical Education (CME) [42].

The appropriate subfield in medical physics for this practice parameter is Diagnostic Medical Physics. (ACR Resolution 17, adopted in 1996 – revised in 2008, 2012, 2022, Resolution 41f)

III. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

C. Non-Physician Radiology Provider (NPRP)

NPRPs are all Non-Physician Providers (eg, RRA, RPA, RA, PA, NP, ...) who assist with or participate in portions of the practice of a radiologist-led team (Radiologists = diagnostic, interventional, neurointerventional radiologists,

radiation oncologists, and nuclear medicine physicians). The term "NPRP" does not include radiology, CT, US, NM MRI technologists, or radiation therapists who have specific training for radiology related tasks (eg, acquisition of images, operation of imaging and therapeutic equipment) that are not typically performed by radiologists.

The term 'radiologist-led team' is defined as a team supervised by a radiologist (ie, diagnostic, interventional, neurointerventional radiologist, radiation oncologist, and nuclear medicine physician) and consists of additional healthcare providers including RRAs, PAs, NPs, and other personnel critical to the provision of the highest quality of healthcare to patients. (ACR Resolution 8, adopted 2020).

III. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

D. Radiologic Technologist

The technologist, together with the physician and/or the nursing personnel, should be responsible for patient comfort. The technologist should be able to prepare and position the patient for the ESI procedure. The technologist should obtain the imaging data in a manner prescribed by the supervising physician. The technologist should also perform regular quality control testing of the equipment under the supervision of the Qualified Medical Physicist.

The technologist should have appropriate training and experience in the ESI procedure and be certified by the American Registry of Radiologic Technologists (ARRT) and/or have an unrestricted state license.

III. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

E. Nursing Services

Nursing services can be an integral part of the team for perioperative patient management and education and assist the physician in monitoring the patient during the ESI procedure, particularly if conscious sedation is given.

IV. WRITTEN REQUEST FOR THE EXAMINATION

The written or electronic request for an image-guided epidural steroid injection 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.

The request for the examination must be originated by a physician or other appropriately licensed health care provider. The accompanying clinical information should be provided by a physician or other appropriately licensed health care provider familiar with the patient's clinical problem or question and consistent with the state's scope of practice requirements. (ACR Resolution 35 adopted in 2006 – revised in 2016, Resolution 12-b)

V. SPECIFICATIONS OF THE PROCEDURE

A. Image Guidance

1. No image guidance
   Historically, ESI were performed without any imaging guidance, resulting in erroneous placement in up to 30% of injections [39]. Because of this and the potential for intrathecal and intravascular injections, image guidance is strongly recommended for spine interventions.

2. Fluoroscopic Guidance
   According to the multispecialty FDA Safe Use Initiative Expert Working Group, image guidance for all cervical and lumbar interlaminar injections is recommended to avoid inadvertent spinal cord penetration,

intravascular, or intrathecal placement. Lateral or oblique views are recommended to gauge depth of needle insertion [11]. Fluoroscopic guidance allows accurate needle placement when combined with contrast medium injection [39, 43, 44]. Both C-arm and biplane fluoroscopy provide multiplanar imaging of the target anatomy, which can help reduce procedural time [45] and are important to perform the procedure safely. Radiation dose from fluoroscopic guidance is lower for patients than with CT-guidance [46].

3. CT and CT fluoroscopic (CTF) guidance
   CT guidance and CTF guidance are being increasingly used for various procedures, including biopsies, drainages, ESI, and TFESI, because this allows for highly accurate needle guidance. CT guidance delineates the soft tissue (eg, nerve, vessels, dura, fat, and muscle) and osseous structures, unlike fluoroscopic guidance, which only provides visualization of bony landmarks. Radiation dose to the patient and interventionalist can be minimized with the use of intermittent fluoroscopy and low milliampere-seconds (mAs) [47-49]. Additionally, modification of planning CT can reduce the radiation exposure in CTF lumbar spine injections [50]. CTF guidance enables real-time cross-sectional visualization of needle placement into the epidural space to avoid neural and vascular structures as well as osseous structures, particularly when there is spinal stenosis or interlaminar narrowing [51]. In addition, CT and CTF enable the evaluation of spinal canal and paraspinal regions before insertion of the needle, to permit diagnosis of synovial cysts or cysts of the ligamentum flavum, severe spinal stenosis, epidural scarring, and postoperative thecal sac deformity in patients, which may be potential causes of inaccurate needle placement or procedure failure. Patient body habitus affects the radiation dose from such procedures, decreasing body size results in increases in organ dose during CTF-guided interventions. Therefore, small patients should have tube current reduced compared to average patients to avoid relatively increased organ dose. Tube current of 30 to 40 mAs is adequate for lumbar interventions in most average sized patients. Modified tube current settings of 10 to 20 mAs and 50 to 70 mAs would be appropriate for small and oversized patients, respectively [52]. However, dose considerations must not supersede the need for adequate anatomic visualization sufficient to allow for technical success and to minimize procedural complications.

4. US
   Ultrasonography is highly effective in accurately guiding the epidural needle placement and produces comparative treatment outcome as fluoroscopy [53, 54]. US-guidance offers the advantages of delineating vessels in the needle trajectory [55] and no radiation exposure. However, US has significant limitations based on body habitus and pathology, and operator dependent skills and is typically not used for performing these procedures.

V. SPECIFICATIONS OF THE PROCEDURE

B. Facility

The choice of image guidance is a matter of operator preference and patient characteristics. Nevertheless, a facility should possess the following:

1. Prompt access to advanced imaging for diagnosis as well as surgical, interventional, and medical management of complications.
2. A procedural suite large enough to allow safe and straightforward transfer of the patient from bed to procedural table with sufficient space for appropriate positioning of patient monitoring equipment, anesthesia equipment, respirators, etc. There should be adequate space for the operating team to work unencumbered on either side of the patient and for the circulation of other staff within the room without contaminating the sterile conditions.
3. Imaging and image recording must be consistent with the ALARA radiation safety guidelines.
4. Observation: the facility must provide adequate resources for observing patients during and after spine pain interventional procedures. Physiologic monitoring devices appropriate to the patient's needs—including blood pressure monitoring, pulse oximetry, and electrocardiography—and equipment for cardiopulmonary resuscitation must be available in the procedural suite.

V. SPECIFICATIONS OF THE PROCEDURE

C. Medications

The steroids used in ESI may be particulate versus nonparticulate preparations, which is based on the solubility of the synthetic corticosteroids within water and on their aggregation characteristics. Particulate corticosteroids have the potential to embolize with risk for occlusion of small vessels and subsequent ischemic injury of the brain or spinal cord [56] in contrast to nonparticulate steroids which dissolve immediately. Due to safety concerns, the multispecialty FDA Safe Use Initiative Expert Working Group has recommended nonparticulate steroids as the first-line agent for cervical and lumbar transforaminal injections rather than particulate steroids [11]; however, this practice suggestion was not without controversy, as some clinicians perceive the guidance as too broadly applied [57]There remains substantive variation in both the published literature and clinical practice regarding the use of particulate steroid formulations in epidural steroid injections, reflecting the complexity of risk-benefit considerations [14, 58]. As concurrence among experienced practitioners is not universal, we advocate for a more nuanced approach which includes latitude for practitioners to exercise their judgement regarding the use of particulate steroids, in keeping with evolving evidence and clinical experience [13, 59]. Additional areas of evolving investigation include elucidating the differences in duration of therapeutic effect of particulate versus nonparticulate steroids and the risk-benefit profile of the use of preservatives in the corticosteroid preparation. Such nuances in the interpretation of available data are well documented, for example, by a European collaborative of 4 pain society members of the World Institute of Pain, prompted by the fact that the nonparticulate steroid dexamethasone was not freely available in the collaborative countries [60, 61]. There are numerous studies suggesting timing and frequency for ESI. A systematic review of literature by Manchikanti et al provides guidelines for frequency of interventions, regardless of approach [29]. A review of injectable corticosteroids and local anesthetics by MacMahon et al [62] discusses the variety of formulations and potential adverse effects of medications used in spine interventions.

V. SPECIFICATIONS OF THE PROCEDURE

D. Patient Care

1. Preprocedural Care

a. The clinical history and findings, including the indications for the procedure, must be reviewed and recorded in the patient's medical record by the physician performing the procedure. Specific inquiry should be made with respect to relevant medications, prior allergic reactions, and bleeding/clotting status. Refer to multisociety guidelines for interventional spine procedures in patients on antiplatelet and anticoagulant medications [63].
b. Examination: the vital signs and the results of physical and neurological examinations may be obtained and recorded.
c. Indications: the indication(s) for the procedure, including (if applicable) documentation of 6 weeks of physical therapy and failed medical therapy, must be recorded.
d. Informed consent should be obtained prior to any sedation.
e. Preprocedural imaging should be reviewed (see below).

Preprocedural imaging assessment of the posterior epidural space is important to determine that there is sufficient epidural space at the target segmental level to allow safe needle placement. Contents of the epidural space include the epidural fat, spinal nerves, extensive venous plexuses, lymphatics, and connective tissue (eg, plica mediana dorsalis and scar tissue after previous surgical intervention). The amount of posterior epidural fat increases with caudal progression, measuring approximately 0.4 mm at C7 to T1, 7.5 mm in the upper thoracic spine, and 4 to 7 mm from T11 to L5 [64, 65]. Epidural lipomatosis (ie, excessive hypertrophy and abnormal accumulation of epidural fat) may also be seen with long-term exogenous steroid use and obesity, and possibly with prior ESI, although the data regarding this latter association are of low quality [66].

Cross-sectional imaging, particularly MRI, is helpful to exclude "red flags," such as fracture and tumor, and depiction of features that can alter the level of procedural difficulty such as severe canal stenosis and disc herniation. Furthermore, MRI may help decide whether a patient will benefit from an ESI by delineating the site of pathology for appropriate targeting [67, 68].

V. SPECIFICATIONS OF THE PROCEDURE

D. Patient Care

2. Procedural Care

a. Time out and checklist: a formal "time out" and verification of the correct patient with introduction of each member of the team, along with a checklist for reviewing of consent, possible complications, medications, prior imaging, need for sedation, and marking of site is recommended.
b. Extension tubing: the multispecialty FDA Safe Use Initiative Expert Working Group recommends extension tubing after needle placement in a safe location to avoid dislodging it when syringes are connected [11] Aseptic technique should follow recommended Centers for Disease Control and Prevention surgical guidelines [69].
c. Intravenous access: some interventionalists may prefer that patients have intravenous access in place for the administration of fluids and medications as needed
d. Monitoring: monitoring of vital signs and pulse oximetry may be considered whether or not sedation is being given for the ESI procedure. Administration of sedation for ESI should be in accordance with the ACR–SIR Practice Parameter for Minimal and/or Moderate Sedation/Analgesia [70]. Appropriately trained personnel should be present and have primary responsibility for monitoring the patient. For cervical procedures, deep sedation, or unresponsiveness at the time of injection is not recommended [11]. There is agreement by all societies that sedation should be light enough to allow the patient to communicate pain or other adverse sensations or events during the procedure, especially when performed in the cervical region [11].

V. SPECIFICATIONS OF THE PROCEDURE

D. Patient Care

3. Postprocedural Care

a. Monitoring: the operating physician or a qualified designee (another physician or a nurse) should evaluate the patient after the initial postprocedural period. Initial ambulation of the patient must be carefully supervised. The physician or designee must be available for continuing postprocedural care at the facility and after discharge. Follow-up visits should be arranged prior to the patient leaving the facility.
b. Documentation: a procedural note should be written in the patient's medical record summarizing the course of the procedure and what was accomplished, any immediate complications, and the patient's status at the conclusion of the procedure. This information should be communicated to the referring physician in a timely manner.

VI. EQUIPMENT SPECIFICATIONS

Equipment performance monitoring should be in accordance with the ACR–AAPM Technical Standard for Diagnostic Medical Physics Performance Monitoring of Computed Tomography (CT) Equipment [71], ACR–AAPM Technical Standard for Diagnostic Medical Physics Performance Monitoring of Fluoroscopic Equipment [72], ACR–AAPM Technical Standard for Diagnostic Medical Physics Performance Monitoring of Magnetic Resonance (MR) Imaging Equipment [73], and ACR–AAPM Technical Standard for Diagnostic Medical Physics Performance Monitoring of Real Time Ultrasound Equipment [74]

VII. DOCUMENTATION

Reporting should be in accordance with the ACR–SIR–SPR Practice Parameter for the Reporting and Archiving of Interventional Radiology Procedures [75].

The supervising physician must have adequate understanding of the indications, risks, and benefits of the procedure, as well as alternative procedures or techniques. Informed consent must be obtained and must comply with the ACR–SIR–SPR Practice Parameter on Informed Consent for Image-Guided Procedures [76].

Despite its acceptance as a relatively safe procedure, ESI is not without risk [77, 78]. ESI can be associated with

several minor and/or temporary complications and side effects as well as major and/or permanent complications. Risks cited may include, but are not limited to, transient weakness and numbness be related to the local anesthetic, vasovagal reaction [79], headache, infection, bleeding (including intraspinal hematoma), allergic reaction, vessel injury, worsening pain or paralysis, spinal cord or nerve injury, arachnoiditis, unintended dural puncture including the possibility of spinal headache requiring a blood patch [80-85] systemic steroid effects [86-89], or death. The potential need for immediate surgical intervention should be discussed. The possibility that the patient may or may not experience significant pain relief should also be discussed.

VIII. RADIATION SAFETY IN IMAGING

Radiologists, medical physicists, non-physician radiology providers**,** radiologic technologists, and all supervising physicians have a responsibility for safety in the workplace by keeping radiation exposure to staff, and to society as a whole, "as low as reasonably achievable" (ALARA) and to assure that radiation doses to individual patients are appropriate, taking into account the possible risk from radiation exposure and the diagnostic image quality necessary to achieve the clinical objective. All personnel who work with ionizing radiation must understand the key principles of occupational and public radiation protection (justification, optimization of protection, application of dose constraints and limits) and the principles of proper management of radiation dose to patients (justification, optimization including the use of dose reference levels). https://www-pub.iaea.org/MTCD/Publications/PDF/PUB1775_web.pdf

Nationally developed guidelines, such as the ACR's Appropriateness Criteria®, should be used to help choose the most appropriate imaging procedures to prevent unnecessary radiation exposure.

Facilities should have and adhere to policies and procedures that require ionizing radiation examination protocols (radiography, fluoroscopy, interventional radiology, CT) to vary according to diagnostic requirements and patient body habitus to optimize the relationship between appropriate radiation dose and adequate image quality. Automated dose reduction technologies available on imaging equipment should be used, except when inappropriate for a specific exam. If such technology is not available, appropriate manual techniques should be used.

Additional information regarding patient radiation safety in imaging is available from the following websites – Image Gently® for children (www.imagegently.org) and Image Wisely® for adults (www.imagewisely.org). These advocacy and awareness campaigns provide free educational materials for all stakeholders involved in imaging (patients, technologists, referring providers, medical physicists, and radiologists).

Radiation exposures or other dose indices should be periodically measured by a Qualified Medical Physicist in accordance with the applicable ACR Technical Standards. Monitoring or regular review of dose indices from patient imaging should be performed by comparing the facility's dose information with national benchmarks, such as the ACR Dose Index Registry and relevant publications relying on its data, applicable ACR Practice Parameters, NCRP Report No. 172, Reference Levels and Achievable Doses in Medical and Dental Imaging: Recommendations for the United States or the Conference of Radiation Control Program Director's National Evaluation of X-ray Trends; 2006, 2009, amended 2013, revised 2023 (Res. 2d).

IX. QUALITY CONTROL AND IMPROVEMENT, SAFETY, INFECTION CONTROL, AND PATIENT EDUCATION

Policies and procedures related to quality, patient education, infection control, and safety should be developed and implemented in accordance with the ACR Policy on Quality Control and Improvement, Safety, Infection Control, and Patient Education appearing under the heading Position Statement on Quality Control and Improvement, Safety, Infection Control and Patient Education on the ACR website (https://www.acr.org/Advocacy/Position-Statements/Quality-Control-and-Improvement).

ACKNOWLEDGEMENTS

Writing Committee – members represent their societies in the initial and final revision of this practice parameter

ACR
Blackham, Kristine A MD, Chair
Amrhein, Timothy J MD
Smirniotopoulos, John MD

ASNR
Barr, John MD
Gibbs, Wende N. MD
Thaker, Ashesh A MD

SNIS
Brook, Allan L MD
Ortiz, A. Orlando MBA, MD

ASSR
Brown, Patrick MD
Lee, Seon-Kyu MD, PhD
Vander Velde, Theodore L MD

SIR
Gupta, Amit MD
Johnson, Thor MD

Committee on Practice Parameters - Neuroradiology
(ACR Committee responsible for sponsoring the draft through the process)

Shah, Lubdha M MD, Chair
Amrhein, Timothy J MD
Becker, Jennifer L MD
Chaudhry, Umar S MD
Hutchins, Troy A MD
Ormsby, Jacob MBA, MD
Sio, Terence Tai-Weng MD, MS
Aiken, Ashley H MD
Austin, Matthew J MD
Blackham, Kristine A MD
Chiang, Gloria C MD
Mazaheri, Parisa MD
Riley, Kalen MD

Committee on Practice Parameters and Technical Standards
(ACR Committee responsible for sponsoring the draft through the process)

Caplin, Drew M MD

Committee on Practice Parameters - Interventional
(ACR Committee responsible for sponsoring the draft through the process)

Kaufman, Claire MD, Chair
Dickey, Kevin MD
Lee, Margaret H MD
Marx, M Victoria MD
Tomihama, Roger T MD
Daly, Kevin MD
Kay, Dennis MD
Makary, Mina S MD
Noor, Amir MD
Yeisley, Christopher MD

Jordan, John E MD, Chair, Commission on Neuroradiology
Larson, David B MBA, MD, Chair, Commission on Quality and Safety
Min, Robert MD, Chair, Commission on Interventional Radiology

Comments Reconciliation Committee

Batlle, Juan C MBA, MD - CSC, Chair
Amrhein, Timothy J MD
Blackham, Kristine A MD
Brown, Patrick MD
Gibbs, Wende N. MD
Johnson, Thor MD
Kaufman, Claire MD
Lee, Seon-Kyu MD, PhD
Ortiz, A. Orlando MBA, MD
Smirniotopoulos, John MD
Vander Velde, Theodore L MD
Chu, Sammy MD - CSC, Co-Chair
Barr, John MD
Brook, Allan L MD
Caplin, Drew M MD
Gupta, Amit MD
Jordan, John E MD
Larson, David B MBA, MD
Min, Robert MD
Shah, Lubdha M MD
Thaker, Ashesh A MD

REFERENCES

1. Lo Bianco G, Tinnirello A, Papa A, et al. Interventional Pain Procedures: A Narrative Review Focusing on Safety and Complications. Part 1 Injections for Spinal Pain. J Pain Res. 2023;16():1637-1646.

2. Peev N, Zygourakis C, Sippl C, Grasso G, Oertel J, Sharif S. Acute back pain - Role of injection techniques and surgery: WFNS spine committee recommendations. [Review]. World Neurosurgery: X. 22:100315, 2024 Apr.
3. Hassan KZ, Sherman AL. Epidural Steroids. StatPearls Publishing. 2024 01.
4. Peckham ME, Hutchins TA, Shah LM. Conventional Image-Guided Procedures for Painful Spine. [Review]. Neuroimaging Clinics of North America. 29(4):539-551, 2019 Nov.
5. Manchikanti L, Knezevic NN, Navani A, et al. Epidural Interventions in the Management of Chronic Spinal Pain: American Society of Interventional Pain Physicians (ASIPP) Comprehensive Evidence-Based Guidelines. [Review]. Pain Physician. 24(S1):S27-S208, 2021 01.
6. Deer TR, Grider JS, Pope JE, et al. The MIST Guidelines: The Lumbar Spinal Stenosis Consensus Group Guidelines for Minimally Invasive Spine Treatment. Pain Pract. 2019 Mar;19(3):250-274.
7. Manchikanti L, Knezevic E, Knezevic NN, et al. Epidural Injections for Lumbar Radiculopathy or Sciatica: A Comparative Systematic Review and Meta-Analysis of Cochrane Review. Pain Physician. 24(5):E539-E554, 2021 08.
8. Manchikanti L, Knezevic E, Knezevic NN, et al. A Comparative Systematic Review and Meta-Analysis of 3 Routes of Administration of Epidural Injections in Lumbar Disc Herniation. Pain Physician. 24(6):425-440, 2021 09.
9. Sayed D, Grider J, Strand N, et al. The American Society of Pain and Neuroscience (ASPN) Evidence-Based Clinical Guideline of Interventional Treatments for Low Back Pain. J Pain Res. 2022;15():3729-3832.
10. Food and Drug Administration. FDA drug safety communication: FDA requires label changes to warn of rare but serious neurologic problems after epidural corticosteroid injections for pain. Available at: https://www.fda.gov/drugs/drug-safety-and-availability/fda-drug-safety-communication-fda-requires-label-changes-warn-rare-serious-neurologic-problems-after.
11. Rathmell JP, Benzon HT, Dreyfuss P, et al. Safeguards to prevent neurologic complications after epidural steroid injections: consensus opinions from a multidisciplinary working group and national organizations. Anesthesiology. 2015 May;122(5):974-84.
12. Maus T. The Anatomy, Technique, Safety, and Efficacy of Image-Guided Epidural Access. [Review]. Radiologic Clinics of North America. 62(2):199-215, 2024 Mar.
13. Bush K, Mandegaran R, Robinson E, Zavareh A. The safety and efficiency of performing cervical transforaminal epidural steroid injections under fluoroscopic control on an ambulatory/outpatient basis. European Spine Journal. 29(5):994-1000, 2020 05.
14. Peckham ME, Miller TS, Amrhein TJ, Hirsch JA, Kranz PG. Image-Guided Spine Interventions for Pain: Ongoing Controversies. AJR. American Journal of Roentgenology. 220(5):736-745, 2023 05.
15. Benyamin RM, Manchikanti L, Parr AT, et al. The effectiveness of lumbar interlaminar epidural injections in managing chronic low back and lower extremity pain. Pain Physician. 2012;15(4):E363-404.
16. Olmarker K, Rydevik B, Holm S. Edema formation in spinal nerve roots induced by experimental, graded compression. An experimental study on the pig cauda equina with special reference to differences in effects between rapid and slow onset of compression. Spine (Phila Pa 1976). 1989 Jun;14(6):569-73.
17. Rydevik B, Brown MD, Lundborg G. Pathoanatomy and pathophysiology of nerve root compression. Spine (Phila Pa 1976). 1984;9(1):7-15.
18. Lin;JH, Chiang YH, Chen CC. Lumbar radiculopathy and its neurobiological basis. World J Anesthesiol 2014;3:162-73.
19. Abram SE, O'Connor TC. Complications associated with epidural steroid injections. Reg Anesth. 1996;21(2):149-62.
20. Derby R, Lee SH, Date ES, Lee JH, Lee CH. Size and aggregation of corticosteroids used for epidural injections. Pain Med. 2008 Mar;9(2):227-34.
21. Johansson A, Hao J, Sjölund B. Local corticosteroid application blocks transmission in normal nociceptive C-fibres. Acta Anaesthesiol Scand. 1990 Jul;34(5):335-8.
22. Kantrowitz F, Robinson DR, McGuire MB, Levine L. Corticosteroids inhibit prostaglandin production by rheumatiod synovia. Nature. 1975 Dec 25;258(5537):737-9.
23. Saal JS, Franson RC, Dobrow R, Saal JA, White AH, Goldthwaite N. High levels of inflammatory phospholipase A2 activity in lumbar disc herniations. Spine (Phila Pa 1976). 1990 Jul;15(7):674-8.
24. Manchikanti L, Kaye AD, Manchikanti K, Boswell M, Pampati V, Hirsch J. Efficacy of epidural injections in the treatment of lumbar central spinal stenosis: a systematic review. Anesth Pain Med. 2015 Feb;5(1):e23139.
25. Arnér S, Lindblom U, Meyerson BA, Molander C. Prolonged relief of neuralgia after regional anesthetic blocks. A call for further experimental and systematic clinical studies. Pain. 1990 Dec;43(3):287-297.
26. Cassuto J, Sinclair R, Bonderovic M. Anti-inflammatory properties of local anesthetics and their present and potential clinical implications. Acta Anaesthesiol Scand. 2006 Mar;50(3):265-82.
27. Kaye AD, Manchikanti L, Abdi S, et al. Efficacy of Epidural Injections in Managing Chronic Spinal Pain: A Best

Evidence Synthesis. Pain Physician. 2015 Nov;18(6):E939-1004.
28. Lavoie PA, Khazen T, Filion PR. Mechanisms of the inhibition of fast axonal transport by local anesthetics. Neuropharmacology. 1989 Feb;28(2):175-81.
29. Manchikanti L, Abdi S, Atluri S, et al. An update of comprehensive evidence-based guidelines for interventional techniques in chronic spinal pain. Part II: guidance and recommendations. Pain Physician. 2013 Apr;16(2 Suppl):S49-283.
30. Manchikanti L, Benyamin RM, Falco FJ, Kaye AD, Hirsch JA. Do Epidural Injections Provide Short- and Long-term Relief for Lumbar Disc Herniation? A Systematic Review. Clin Orthop Relat Res. 2015 Jun;473(6):1940-56.
31. Manchikanti L, Nampiaparampil DE, Manchikanti KN, et al. Comparison of the efficacy of saline, local anesthetics, and steroids in epidural and facet joint injections for the management of spinal pain: A systematic review of randomized controlled trials. Surg Neurol Int. 2015;6(Suppl 4):S194-235.
32. Pasqualucci A. Experimental and clinical studies about the preemptive analgesia with local anesthetics. Possible reasons of the failure. Minerva Anestesiol. 1998 Oct;64(10):445-57.
33. Linton SJ, Boersma K, Jansson M, Svärd L, Botvalde M. The effects of cognitive-behavioral and physical therapy preventive interventions on pain-related sick leave: a randomized controlled trial. Clin J Pain. 2005;21(2):109-19.
34. Wolff MW, Levine LA. Cervical radiculopathies: conservative approaches to management. Phys Med Rehabil Clin N Am. 2002 Aug;13(3):589-608, vii.
35. Murakibhavi VG, Khemka AG. Caudal epidural steroid injection: a randomized controlled trial. Evid Based Spine Care J. 2011 Nov;2(4):19-26.
36. Deer T, Sayed D, Michels J, Josephson Y, Li S, Calodney AK. A Review of Lumbar Spinal Stenosis with Intermittent Neurogenic Claudication: Disease and Diagnosis. Pain Med. 2019 Dec 01;20(Suppl 2):S32-S44.
37. Hooten WM, Cohen SP. Evaluation and Treatment of Low Back Pain: A Clinically Focused Review for Primary Care Specialists. [Review]. Mayo Clinic Proceedings. 90(12):1699-718, 2015 Dec.
38. Narouze S, Benzon HT, Provenzano D, et al. Interventional Spine and Pain Procedures in Patients on Antiplatelet and Anticoagulant Medications (Second Edition): Guidelines From the American Society of Regional Anesthesia and Pain Medicine, the European Society of Regional Anaesthesia and Pain Therapy, the American Academy of Pain Medicine, the International Neuromodulation Society, the North American Neuromodulation Society, and the World Institute of Pain. Reg Anesth Pain Med. 2018 Apr;43(3):225-262.
39. White AH, Derby R, Wynne G. Epidural injections for the diagnosis and treatment of low-back pain. Spine (Phila Pa 1976). 1980;5(1):78-86.
40. Desmond FA, Harmon D. Ultrasound-guided symphysis pubis injection in pregnancy. Anesth Analg. 2010 Nov;111(5):1329-30.
41. Kalin A, Woods D. Neuraxial blockade in a patient with hepatitis C. Can J Anesthesia 2008;Supplement vol. 55.
42. American College of Radiology. ACR Practice Parameter for Continuing Medical Education. Available at https://gravitas.acr.org/PPTS/GetDocumentView?docId=130+&releaseId=2
43. Johnson BA. Image-guided epidural injections. Neuroimaging Clin N Am. 2000 Aug;10(3):479-91.
44. Watanabe AT, Nishimura E, Garris J. Image-guided epidural steroid injections. Tech Vasc Interv Radiol. 2002 Dec;5(4):186-93.
45. Mathis JM. Epidural steroid injections. Neuroimaging Clin N Am. 2010 May;20(2):193-202.
46. Dietrich TJ, Peterson CK, Zeimpekis KG, Bensler S, Sutter R, Pfirrmann CWA. Fluoroscopy-guided versus CT-guided Lumbar Steroid Injections: Comparison of Radiation Exposure and Outcomes. Radiology. 290(3):752-759, 2019 03.
47. Paulson EK, Sheafor DH, Enterline DS, McAdams HP, Yoshizumi TT. CT fluoroscopy--guided interventional procedures: techniques and radiation dose to radiologists. Radiology. 2001 Jul;220(1):161-7.
48. Fenster AJ, Fernandes K, Brook AL, Miller T. The Safety of CT-Guided Epidural Steroid Injections in an Older Patient Cohort. Pain physician. 19(8):E1139-E1146, 2016 Nov-Dec.
49. Lazarus MS, Forman RB, Brook AL, Miller TS. Radiation Dose and Procedure Time for 994 CT-guided Spine Pain Control Procedures. Pain Physician. 2017 May;20(4):E585-E591.
50. Amrhein TJ, Schauberger JS, Kranz PG, Hoang JK. Reducing Patient Radiation Exposure From CT Fluoroscopy-Guided Lumbar Spine Pain Injections by Targeting the Planning CT. AJR Am J Roentgenol. 206(2):390-4, 2016 Feb.
51. Wagner AL. CT fluoroscopy-guided epidural injections: technique and results. AJNR Am J Neuroradiol. 2004;25(10):1821-3.
52. Viola RJ, Nguyen GB, Yoshizumi TT, Stinnett SS, Hoang JK, Kranz PG. Effect of Body Habitus on Radiation Dose During CT Fluoroscopy-Guided Spine Injections. Interv Neuroradiol. 2014 Oct 31;20(5):525-32.
53. Kao SC, Lin CS. Caudal Epidural Block: An Updated Review of Anatomy and Techniques. [Review]. Biomed Res Int. 2017:9217145, 2017.

54. Ahmed M, Ahmad A, Arshad M, Naseer H, Zamarud A. Ultrasound-Guided Versus Conventional Fluoroscopy-Guided Epidural Injection for Radiculopathy. A Meta-Analysis of Randomized Controlled Trials. [Review]. World Neurosurgery. 180:203-212.e4, 2023 Dec.
55. Jee H, Lee JH, Kim J, Park KD, Lee WY, Park Y. Ultrasound-guided selective nerve root block versus fluoroscopy-guided transforaminal block for the treatment of radicular pain in the lower cervical spine: a randomized, blinded, controlled study. Skeletal Radiology. 42(1):69-78, 2013 Jan.
56. MacMahon PJ, Shelly MJ, Scholz D, Eustace SJ, Kavanagh EC. Injectable corticosteroid preparations: an embolic risk assessment by static and dynamic microscopic analysis. AJNR Am J Neuroradiol. 2011;32(10):1830-5.
57. Bateman BT, Brenner GJ. An important step forward in the safe use of epidural steroid injections. Anesthesiology. 2015 May;122(5):964-6.
58. Makkar JK, Singh PM, Jain D, Goudra B. Particulate vs Non-Particulate Steroids for Transforaminal Epidural Steroid Injections: Systematic Review and Meta-analysis of the Current Literature. Pain Physician. 2016 Jul;19(6):327-40.
59. Eworuke E, Crisafi L, Liao J, et al. Risk of serious spinal adverse events associated with epidural corticosteroid injections in the Medicare population. Reg Anesth Pain Med. 2021 Mar;46(3):203-209.
60. Van Boxem K, Rijsdijk M, Hans G, et al. Safe Use of Epidural Corticosteroid Injections: Recommendations of the WIP Benelux Work Group. [Review]. Pain pract.. 19(1):61-92, 2019 01.
61. Duszynski B. Spine Intervention Society Position Statement on Best Practices for Epidural Steroid Injections in the Setting of a Preservative-Free Dexamethasone Shortage. Pain Med. 2019 Jul 01;20(7):1277-1280.
62. MacMahon PJ, Eustace SJ, Kavanagh EC. Injectable corticosteroid and local anesthetic preparations: a review for radiologists. Radiology. 2009 Sep;252(3):647-61.
63. Narouze S, Benzon HT, Provenzano DA, et al. Interventional spine and pain procedures in patients on antiplatelet and anticoagulant medications: guidelines from the American Society of Regional Anesthesia and Pain Medicine, the European Society of Regional Anaesthesia and Pain Therapy, the American Academy of Pain Medicine, the International Neuromodulation Society, the North American Neuromodulation Society, and the World Institute of Pain. Reg Anesth Pain Med. 2015;40(3):182-212.
64. Nickalls RW, Kokri MS. The width of the posterior epidural space in obstetric patients. Anaesthesia. 1986 Apr;41(4):432-3.
65. Reina MA, Franco CD, López A, Dé Andrés JA, van Zundert A. Clinical implications of epidural fat in the spinal canal. A scanning electron microscopic study. Acta Anaesthesiol Belg. 2009;60(1):7-17.
66. Holder EK, Raju R, Dundas MA, Husu EN, McCormick ZL. Is there an association between lumbosacral epidural lipomatosis and lumbosacral epidural steroid injections? A comprehensive narrative literature review. N Am Spine Soc J. 2022 Mar;9():100101.
67. Smith CC, Lin JL, Shokat M, Dosanjh SS, Casthely D. A report of paraparesis following spinal cord stimulator trial, implantation and revision. Pain Physician. 2010;13(4):357-63.
68. Maus T. Imaging the back pain patient. Phys Med Rehabil Clin N Am. 2010 Nov;21(4):725-66.
69. Berríos-Torres SI, Umscheid CA, Bratzler DW, et al. Centers for Disease Control and Prevention Guideline for the Prevention of Surgical Site Infection, 2017. JAMA Surg. 2017 Aug 01;152(8):784-791.
70. American College of Radiology. ACR–SIR Practice Parameter For Minimal and/or Moderate Sedation/Analgesia. Available at https://gravitas.acr.org/PPTS/GetDocumentView?docId=95+&releaseId=2
71. American College of Radiology. ACR–AAPM Technical Standard for Diagnostic Medical Physics Performance Monitoring of Computed Tomography (CT) Equipment. Available at https://gravitas.acr.org/PPTS/GetDocumentView?docId=131+&releaseId=2
72. American College of Radiology. ACR–AAPM Technical Standard for Diagnostic Medical Physics Performance Monitoring of Fuoroscopic Equipment. Available at https://gravitas.acr.org/PPTS/GetDocumentView?docId=117.
73. American College of Radiology. ACR–AAPM Technical Standard for Diagnostic Medical Physics Performance Monitoring of Magnetic Resonance (MR) Imaging Equipment. Available at https://gravitas.acr.org/PPTS/GetDocumentView?docId=57+&releaseId=2
74. American College of Radiology. ACR–AAPM Technical Standard for Diagnostic Medical Physics Performance Monitoring of Real Time Ultrasound Equipment. Available at https://gravitas.acr.org/PPTS/GetDocumentView?docId=118+&releaseId=2
75. American College of Radiology. ACR–SIR–SPR Practice Parameter for the Reporting and Archiving of Interventional Radiology Procedures. Available at https://gravitas.acr.org/PPTS/GetDocumentView?docId=39+&releaseId=2
76. American College of Radiology. ACR–SIR–SPR Practice Parameter on Informed Consent for Image-Guided Procedures. Available at https://gravitas.acr.org/PPTS/GetDocumentView?docId=176+&releaseId=2

77. Abdi S, Datta S, Trescot AM, et al. Epidural steroids in the management of chronic spinal pain: a systematic review. Pain Physician. 2007 Jan;10(1):185-212.
78. Bellini M, Barbieri M. Systemic effects of epidural steroid injections. Anaesthesiol Intensive Ther. 2013;45(2):93-8.
79. Trentman TL, Rosenfeld DM, Seamans DP, Hentz JG, Stanek JP. Vasovagal reactions and other complications of cervical vs. lumbar translaminar epidural steroid injections. Pain Pract. 2009;9(1):59-64.
80. Botwin KP, Gruber RD, Bouchlas CG, Torres-Ramos FM, Freeman TL, Slaten WK. Complications of fluoroscopically guided transforaminal lumbar epidural injections. Arch Phys Med Rehabil. 2000 Aug;81(8):1045-50.
81. Huston CW, Slipman CW, Garvin C. Complications and side effects of cervical and lumbosacral selective nerve root injections. Arch Phys Med Rehabil. 2005 Feb;86(2):277-83.
82. Ma DJ, Gilula LA, Riew KD. Complications of fluoroscopically guided extraforaminal cervical nerve blocks. An analysis of 1036 injections. J Bone Joint Surg Am. 2005 May;87(5):1025-30.
83. Schellhas KP, Pollei SR, Johnson BA, Golden MJ, Eklund JA, Pobiel RS. Selective cervical nerve root blockade: experience with a safe and reliable technique using an anterolateral approach for needle placement. AJNR Am J Neuroradiol. 2007;28(10):1909-14.
84. Pobiel RS, Schellhas KP, Eklund JA, et al. Selective cervical nerve root blockade: prospective study of immediate and longer term complications. AJNR Am J Neuroradiol. 2009 Mar;30(3):507-11.
85. McGrath JM, Schaefer MP, Malkamaki DM. Incidence and characteristics of complications from epidural steroid injections. Pain Med. 2011 May;12(5):726-31.
86. Botwin KP, Gruber RD, Bouchlas CG, et al. Complications of fluoroscopically guided caudal epidural injections. Am J Phys Med Rehabil. 2001 Jun;80(6):416-24.
87. Everett CR, Baskin MN, Speech D, Novoseletsky D, Patel R. Flushing as a side effect following lumbar transforaminal epidural steroid injection. Pain Physician. 2004 Oct;7(4):427-9.
88. Cicala RS, Westbrook L, Angel JJ. Side effects and complications of cervical epidural steroid injections. J Pain Symptom Manage. 1989 Jun;4(2):64-6.
89. DeSio JM, Kahn CH, Warfield CA. Facial flushing and/or generalized erythema after epidural steroid injection. Anesth Analg. 1995 Mar;80(3):617-9.
90. Kimmell KT, Dayoub H, Shakir H, Sincoff EH. Spinal dural attachments to the vertebral column: An anatomic report and review of the literature. Surg Neurol Int. 2011;2():97.
91. Morisot P. [Is posterior lumbar epidural space partitioned?]. Ann Fr Anesth Reanim. 1992;11(1):72-81.
92. Manchikanti L, Falco FJ, Benyamin RM, Gharibo CG, Candido KD, Hirsch JA. Epidural steroid injections safety recommendations by the Multi-Society Pain Workgroup (MPW): more regulations without evidence or clarification. Pain Physician. 2014;17(5):E575-88.
93. Koontz NA, Wiggins RH, Stoddard GJ, Shah LM. Do Superior or Inferior Interlaminar Approach or Bevel Orientation Predispose to Nonepidural Needle Penetration?. AJR Am J Roentgenol. 2017 Oct;209(4):895-903.
94. Huang AJ, Rosenthal DI, Palmer WE. Inadvertent intra-articular lumbar facet joint injection during fluoroscopically guided interlaminar epidural steroid injection. Skeletal Radiology. 40(1):33-45, 2011 Jan.
95. Murthy NS, Maus TP, Aprill C. The retrodural space of Okada. [Review]. AJR. American Journal of Roentgenology. 196(6):W784-9, 2011 Jun.
96. Lehman VT, Murthy NS, Diehn FE, Verdoorn JT, Maus TP. The posterior ligamentous complex inflammatory syndrome: spread of fluid and inflammation in the retrodural space of Okada. [Review]. Clinical Radiology. 70(5):528-35, 2015 May.
97. Huang AJ, Palmer WE. Incidence of inadvertent intra-articular lumbar facet joint injection during fluoroscopically guided interlaminar epidural steroid injection. Skeletal Radiology. 41(2):157-62, 2012 Feb.
98. Kranz PG, Joshi AB, Roy LA, Choudhury KR, Amrhein TJ. Inadvertent Intrafacet Injection during Lumbar Interlaminar Epidural Steroid Injection: A Comparison of CT Fluoroscopic and Conventional Fluoroscopic Guidance. AJNR Am J Neuroradiol. 2017 Feb;38(2):398-402.
99. Goel A, Pollan JJ. Contrast flow characteristics in the cervical epidural space: an analysis of cervical epidurograms. Spine (Phila Pa 1976). 2006 Jun 15;31(14):1576-9.
100. Hogan QH. Epidural anatomy examined by cryomicrotome section. Influence of age, vertebral level, and disease. Reg Anesth. 1996;21(5):395-406.
101. Aldrete JA, Mushin AU, Zapata JC, Ghaly R. Skin to cervical epidural space distances as read from magnetic resonance imaging films: consideration of the "hump pad.". J Clin Anesth. 1998 Jun;10(4):309-13.
102. Hodges SD, Castleberg RL, Miller T, Ward R, Thornburg C. Cervical epidural steroid injection with intrinsic spinal cord damage. Two case reports. Spine (Phila Pa 1976). 1998 Oct 01;23(19):2137-42; discussion 2141-2.

103. Manchikanti L, Rajgopal R, Pampati V. Comparison of three routes of epidural steroid injections in low back pain. Pain Digest 1999;9:277-85.
104. Furman MB, Cuneo AA. Image and Contrast Flow Pattern Interpretation for Attempted Epidural Steroid Injections. Phys Med Rehabil Clin N Am. 2018 Feb;29(1):S1047-9651(17)30070-0.
105. Jeong HS, Lee JW, Kim SH, Myung JS, Kim JH, Kang HS. Effectiveness of transforaminal epidural steroid injection by using a preganglionic approach: a prospective randomized controlled study. Radiology. 2007 Nov;245(2):584-90.
106. Kamble PC, Sharma A, Singh V, Natraj B, Devani D, Khapane V. Outcome of single level disc prolapse treated with transforaminal steroid versus epidural steroid versus caudal steroids. Eur Spine J. 2016 Jan;25(1):217-221.
107. Shim E, Lee JW, Lee E, Ahn JM, Kang Y, Kang HS. Fluoroscopically Guided Epidural Injections of the Cervical and Lumbar Spine. [Review]. Radiographics. 37(2):537-561, 2017 Mar-Apr.
108. Manchikanti L, Cash KA, Pampati V, Damron KS, McManus CD. Evaluation of lumbar transforaminal epidural injections with needle placement and contrast flow patterns: a prospective, descriptive report. Pain Physician. 2004 Apr;7(2):217-23.
109. Slipman CW, Chow DW. Therapeutic spinal corticosteroid injections for the management of radiculopathies. Phys Med Rehabil Clin N Am. 2002 Aug;13(3):697-711.
110. Botwin KP, Gruber RD, Bouchlas CG, et al. Fluoroscopically guided lumbar transformational epidural steroid injections in degenerative lumbar stenosis: an outcome study. Am J Phys Med Rehabil. 2002 Dec;81(12):898-905.
111. Elias M. A rare cause of radiculopathy following transformainal epidual steroid injection. Pain Clinic 1998;11:159-60.
112. Furman MB, O'Brien EM, Zgleszewski TM. Incidence of intravascular penetration in transforaminal lumbosacral epidural steroid injections. Spine (Phila Pa 1976). 2000 Oct 15;25(20):2628-32.
113. Stöhr M, Mayer K. [Nerve-root damage from local injections (author's transl)]. Dtsch Med Wochenschr. 1976 Aug 13;101(33):1218-20.
114. Houten JK, Errico TJ. Paraplegia after lumbosacral nerve root block: report of three cases. Spine J. 2002;2(1):70-5.
115. Manchikanti L, Staats PS, Singh V, et al. Evidence-based practice guidelines for interventional techniques in the management of chronic spinal pain. Pain Physician. 6(1):3-81, 2003 Jan.
116. Boswell MV, Hansen HC, Trescot AM, Hirsch JA. Epidural steroids in the management of chronic spinal pain and radiculopathy. Pain Physician. 2003 Jul;6(3):319-34.
117. Manchikanti L. Transforaminal lumbar epidural steroid injections. Pain Physician. 2000 Oct;3(4):374-98.
118. Kambin P, Sampson S. Posterolateral percutaneous suction-excision of herniated lumbar intervertebral discs. Report of interim results. Clin Orthop Relat Res. 1986 Jun;(207):37-43.
119. Murthy NS, Maus TP, Behrns CL. Intraforaminal location of the great anterior radiculomedullary artery (artery of Adamkiewicz): a retrospective review. Pain Med. 2010 Dec;11(12):1756-64.
120. Levi D, Horn S, Corcoran S. The Incidence of Intradiscal, Intrathecal, and Intravascular Flow During the Performance of Retrodiscal (Infraneural) Approach for Lumbar Transforaminal Epidural Steroid Injections. Pain Med. 2016 Aug;17(8):1416-22.
121. Smuck M, Paulus S, Patel A, Demirjian R, Ith MA, Kennedy DJ. Differential Rates of Inadvertent Intravascular Injection during Lumbar Transforaminal Epidural Injections Using Blunt-Tip, Pencil-Point, and Catheter-Extension Needles. Pain Med. 2015 Nov;16(11):2084-9.
122. Özcan U, Sahin S, Gurbet A, Türker G, Özgür M, Çelebi S. Comparison of blunt and sharp needles for transforaminal epidural steroid injections. Agri. 2012;24(2):85-9.
123. Trinh KH, Gharibo CG, Aydin SM. Inadvertent Intradiscal Injection with TFESI Utilizing Kambin's Retrodiscal Approach in the Treatment of Acute Lumbar Radiculopathy. Pain Pract. 2016 Apr;16(4):E70-3.
124. Provenzano DA, Fanciullo G. Cervical transforaminal epidural steroid injections: should we be performing them?. Reg Anesth Pain Med. 2007;32(2):168; author reply 169-70.
125. Choi E, Nahm FS, Lee PB. Comparison of contrast flow and clinical effectiveness between a modified paramedian interlaminar approach and transforaminal approach in cervical epidural steroid injection. Br J Anaesth. 115(5):768-74, 2015 Nov.
126. Wagner AL. CT fluoroscopic-guided cervical nerve root blocks. AJNR Am J Neuroradiol. 2005 Jan;26(1):43-4.
127. Hoang JK, Apostol MA, Kranz PG, et al. CT fluoroscopy-assisted cervical transforaminal steroid injection: tips, traps, and use of contrast material. AJR Am J Roentgenol. 2010 Oct;195(4):888-94.
128. Richarme D, Thevenin FS, Chevrot A, et al. Cervical radiculopathy: efficiency of CT-guided cervical facet joint corticosteroid injection. Chicago, IL: Radiological Society of North America; 2008.
129. Kim KH, Choi SH, Kim TK, Shin SW, Kim CH, Kim JI. Cervical facet joint injections in the neck and shoulder pain.

J Korean Med Sci. 2005 Aug;20(4):659-62.
130. Bureau NJ, Moser T, Dagher JH, et al. Transforaminal versus intra-articular facet corticosteroid injections for the treatment of cervical radiculopathy: a randomized, double-blind, controlled study. AJNR Am J Neuroradiol. 2014 Aug;35(8):1467-74.
131. Eckel TS, Bartynski WS. Epidural steroid injections and selective nerve root blocks. Tech Vasc Interv Radiol. 2009 Mar;12(1):11-21.

*Practice parameters and technical standards are published annually with an effective date of October 1 in the year in which amended, revised or approved by the ACR Council. For practice parameters and technical standards published before 1999, the effective date was January 1 following the year in which the practice parameter or technical standard was amended, revised, or approved by the ACR Council.

Development Chronology for this Practice Parameter
2019 (Resolution 14)
Amended 2020 (Resolution 8)
Amended 2022 (Resolution 41f)
Amended 2023 (Resolution 2c, 2d)
Revised 2025 (Resolution 18)

Appendix A

DEFINITIONS

The epidural space is essentially continuous from the craniocervical junction to the second sacral segment, with some anatomic compartmentalization by dorsal median connective tissue[90]. It is filled with compressible fat and venous structures [91]. The epidural space can be accessed using different approaches (eg, caudal, interlaminar, and transforaminal). Once the needle is in the epidural space, the medication is injected and epidurography with contrast media is usually performed to verify the proper needle position, and subsequently navigates cranially and caudally within the epidural space. ESIs are performed in the cervical and lumbar spine and less often in the thoracic spine.

Interlaminar ESI:

The epidural needle can be advanced in the midline between adjacent spinous processes or paramidline between the target laminae to traverse the ligamentum flavum and enter the dorsal epidural space. Although usually possible in all cases, in those patients with ossification of the supraspinous ligament or Baastrup disease, the paramidline approach may be preferred. Blunt-tip needles have been advocated for overall safety (eg, decrease risk of dural puncture [92]). Bevel tip orientation may result in inadvertent nonepidural needle penetration during fluoroscopically guided lumbar interlaminar ESI (ILESI), particularly if the needle is directed toward the superior lamina approach and the bevel tip is caudally orientated [93].

During an ILESI, inadvertent intrafacet injection [94] can occur because of needle entry into the retrodural space of Okada, an anatomic space located dorsal to the ligamentum flavum that allows communication between bilateral facet joints and the interspinous bursa at a single spinal level [95, 96]. Needle entry into this space can mimic the loss of resistance normally felt during entrance into the epidural space. However, this nontarget delivery of medication results in decreased effectiveness of the procedure as the medication is not treating the intended pathology. The incidence of inadvertent intrafacet injection during attempted ILESI by using fluoroscopic guidance is reportedly 0.75% to 1.2% [97, 98], which may be an underestimation, whereas that of ILESI performed under CT guidance is 7.5% [98]. Recognizing this false-positive position is important for redirection and appropriate needle tip placement. As such, CT-guidance can be of benefit in situations where conventional fluoroscopic guidance may be challenging or has proven unsuccessful.

The multispecialty FDA Safe Use Initiative Expert Working Group proposed that cervical ILESI be performed at C7-T1, which is based on reports that at other segmental levels the cervical epidural space is often narrow, making the dural sac and spinal cord more susceptible to penetration and injury [99-102].

Transforaminal ESI:

Although ESIs are effective in managing lumbar disc herniation regardless of the approach used (interlaminar, caudal, or transforaminal), the basic principle is to select the approach that will allow injection closest to the source of the pain. Corticosteroids delivered as close as technically feasible to the site of the lesion will generally obtain optimal results (and allows for lowest dose of medication for clinical effectiveness). The transforaminal approach for ESIs is a target-specific approach allowing maximal delivery of medication to the relevant nerve root. With this approach, the injectate flow is directed toward the anterior and lateral epidural space (ie, the inflammatory site between the herniated disc and the anterior nerve root dural sleeve), and may extend over 1 to 2 spinal levels [103, 104]. For a lateralized lumbar disc herniation, a preganglionic transforaminal ESI (TFESI) (at the supra-adjacent intervertebral disc level or one level superior) is preferred by some over a paramidline interlaminar injection [105, 106]. If there is migration of the disc, ganglionic TFESI (at the exiting nerve root level) may be useful [107].

In a lumbar TFESI, the needle may be placed in an intervertebral foramen via a subpedicular/supraneural or infraneural/retrodiscal approach. With the subpedicular approach, the needle is advanced inferior to the pedicle and superolateral to the spinal nerve of interest, toward the "safe triangle”[108]. The supraneural approach decreases risk of damage to the nerve, dorsal root ganglion, and dural sleeve [109, 110]. The disadvantages of this approach include intraneural injection, neural trauma, technical difficulty in the presence of fusion and/or hardware, intravascular injection, intradiscal injection, and spinal cord trauma [80, 111-117].

The infraneural/retrodiscal approach is an alternative TFESI trajectory using Kambin's triangle, which is defined as a right triangle over the dorsolateral disc [118]. In addition to avoiding epidural bleeding and scarring, the advantage of this approach is the decreased risk of intravascular penetration. Murthy et al. reported that the artery of Adamkiewicz (or artery) runs through the "safe triangle,” and this may result in injection of medications within the artery or directly damage a feeding vessel [119]. By spinal angiography, the radiculomedullary artery is located in the superior half of the intervertebral foramen in 97% of cases and is never seen in the inferior one-fifth of the intervertebral foramen [119]. The authors concluded that the safest needle placement for a TFESI, particularly at L3 and above, may be in an inferior and slightly posterior position within the foramen and relative to the nerve. Although there is decreased risk of injuring a radiculomedullary artery, this approach still carries 6.6% risk of vascular injections [120]. Although some authors have found the risk of inadvertent vascular injection during lumbosacral transforaminal injections comparable between blunt-tip and pencil-point needles [121], others have found that blunt needles had decreased incidence of vascular penetration and paresthesias[122]. Other risks of infraneural/retrodiscal TFESI include inadvertent intradiscal penetration (4.7%) [120, 123] and subarachnoid or subdural extra-arachnoid injection (3.1%) [120].

In the cervical spine, a TFESI is performed by inserting the needle posteriorly along the neural foraminal axis, which avoids the anteriorly positioned vertebral artery and the intraforaminal spinal nerve. The interventionalist must be aware of spinal segmental arteries arising from the deep or ascending cervical artery, which enter at variable locations and often course through the foramen, penetrate the dura, and join the anterior and posterior spinal arteries. In addition to the risk of exiting nerve or vessel injury, injection of the particulate steroid directly into one of these vessels can lead to catastrophic spinal cord injury [11].

Given the potential of catastrophic neurologic complications after cervical TFESI, some authors have questioned the continued use of TFESI in this setting[124] and advocate interlaminar midline or paramidline approaches in the cervical spine regardless of disease categories or laterality of symptoms because of the overall safety of an interlaminar approach and possible greater patient comfort[107]. Choi et al found no statistically significant difference in symptom improvement between interlaminar and transforaminal approaches [125] and lower inadvertent vascular uptake and patient discomfort with the latter. Others advocate technical strategies to improve the safety of the procedure [126, 127] or alternative approaches, which potentially carry fewer risks [124, 128]. One such alternative is intra-articular facet steroid injections [128, 129]. Anatomically, the facet joint ventral recess is in close proximity to the exiting spinal nerve root, and leakage of contrast into the foramen can be seen during a facet injection. Therefore, using a facet joint injection approach to deliver corticosteroids in the vicinity of the target spinal nerve root may be a viable alternative to the riskier transforaminal approach [128, 130].

Selective nerve root block:
Revised 2025 (Resolution 18)

A selective nerve root block has a similar approach as a TFESI; however, the needle tip is not advanced as medially into the neural foramen. Rather, the goal of this approach is to cover the target nerve, particularly when isolated spinal nerve root irritation is suspected. Selective nerve blocks are often requested to provide more specific diagnostic information via delivery in a selective fashion [131].

Caudal ESI:

The epidural space is accessed via the sacral canal through the sacral hiatus coccygeal ligament using fluoroscopic guidance [53]. With the caudal/interlaminar route, the flow of injectate is predominantly into the posterior epidural space[103]. This is an alternative approach when transforaminal or interlaminar approaches are technically challenging or contraindicated.