

# AANA Journal Course

## A Review of the Analgesic Benefits and Potential Complications Related to Epidural Corticosteroid Injections

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*The Institute of Medicine has reported that greater than 115 million adults in the United States are living with some form of chronic pain. Back pain is the most prevalent and is associated with high individual morbidity and increased healthcare costs. One approach for the management of chronic back pain involves the injection of corticosteroids in the epidural space. This interventional approach requires advanced training with techniques that vary according to the level of the vertebral column where the injection is to be performed. The primary rationale for epidural steroid injection is to reduce the inflammation surrounding the spinal nerve root as it exits the neuroforamen. Injections are performed at levels that correspond*

*most appropriately with the patient's clinical presentation, physical findings, and radiographic findings. Epidural steroid injections are considered safe and effective, and are supported by evidence for the treatment of radicular pain. Complications from epidural steroid injections are rare but can be catastrophic, including permanent disability and death. The focus of this article is to understand how technique and selection of specific corticosteroids used for epidural injection can manage chronic back and radicular pain effectively while minimizing risk that leads to unnecessary harm.*

**Keywords:** Back pain, corticosteroid, epidural steroid injection, pain management.

### Objectives:

At the completion of this course, the reader should be able to:

1. Identify the therapeutic benefits and potential complications related to epidural corticosteroid injections.
2. Describe different approaches used to access the epidural space along different levels of the vertebral column.
3. Review the pharmacology of endogenous and exogenous corticosteroid solutions.
4. Differentiate between particulate and nonparticulate corticosteroids, including the indications and contraindications for each.
5. Identify the complex interaction that exists among the various approaches to the epidural space, the appropriate selection of epidural corticosteroid solutions, and the potential for complications.

### Introduction

The National Academies' Institute of Medicine (now the Health and Medicine Division) has reported that more than 115 million adult in the United States are living with some form of chronic pain. Back pain is a form of chronic pain that is often associated with high individual morbidity and increased healthcare costs.<sup>1</sup> Pain can originate from the components of the spinal column, such as the intervertebral disks, vertebral bodies, facet joints, spinal nerve roots, and surrounding supporting muscles and ligaments, but also from the adjacent abdominal and pelvic viscera.<sup>2</sup> Inflammation of the spinal nerve root caused by pro-inflammatory mediators and/or mechanical compression may lead to radicular symptoms and pain.

Radiculopathy is a syndrome of neurologic conductive loss, sensory and/or motor, arising from any compressive force.<sup>2</sup> It is not uniformly associated with radicular pain

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## Glossary

**Corticosteroid hormones:** Key mediators in the maintenance of normal physiology and homeostasis, these hormones form complex adaptive protective mechanisms in the setting of internal and/or external stressors.

**Corticosteroids, commercially prepared:** Include methylprednisolone, triamcinolone, betamethasone, and dexamethasone.

**Cortisol:** The main glucocorticoid under the control of the hypothalamic-pituitary-adrenal axis.

**Particulate vs nonparticulate corticosteroid:** Broad categories based on corticosteroid particle size and aggregation compared with the size of red blood cells via light microscopy data. Specifically, if corticosteroid particles are larger than, or aggregates are larger than, a red blood cell, the typical diameter of which is 6 to 8  $\mu\text{m}$ , then it is a particulate.

**Radicular pain symptoms:** Described as burning, sharp, and/or lancinating quality of pain; may involve paresthesias and numbness in a typical dermatomal distribution, with or without signs of weakness or diminished reflexes.

**Radiculopathy:** A syndrome of neurologic conductive loss, sensory and/or motor, arising from any compressive force.

symptoms. Epidural administration of corticosteroids (see Glossary) may reduce these inflammatory changes in or around the nerve, thereby decreasing pain and improving function. Evidence supports the use of caudal, interlaminar (IL), and transforaminal (TF) epidural corticosteroid injections for upper extremity, back, and lower extremity radicular pain.<sup>2</sup>

In the human body there are 31 paired spinal nerves grouped according to the corresponding regions of the vertebral column from which they are derived. There are 8 paired cervical, 12 paired thoracic, 5 paired lumbar, 5 paired sacral, and 1 coccygeal nerve.<sup>3</sup> The spinal nerve root exits the narrow neuroforamen and further divides into ventral and dorsal ramus. The dorsal ramus supplies the posterior aspect of the body with both motor and sensory innervation of the skin and muscles of the back. The ventral ramus supplies the anterior aspect of the body with both motor and sensory innervation to the upper and lower extremities. Inflammation of the spinal nerve root as it exits this narrow neuroforamen from compression may present as disturbances in both sensory and motor nerve conduction to the corresponding areas of spinal nerve root innervation.<sup>4</sup>

Spinal nerve root pain is associated with the release of pro-inflammatory mediators often from ruptured disk material or inflamed tissue and the mechanical compression of the nerve root from bone, disk material, or both. These sources can occur independently or in combination.<sup>5,6</sup> The resulting pain sensations have been described using the term *radicular pain* provided they follow the course of distribution of a corresponding spinal nerve root.<sup>2</sup> Radicular pain symptoms (see Glossary) can be described as burning, sharp and/or lancinating quality of pain; sometimes paresthesias; and numbness in a typical dermatomal distribution, with or without the signs of weakness or diminished reflexes.<sup>2,4</sup> The incidence of radicular symptoms in patients with lower back pain has been reported to range from 12% to 40%.<sup>4,6,7</sup>

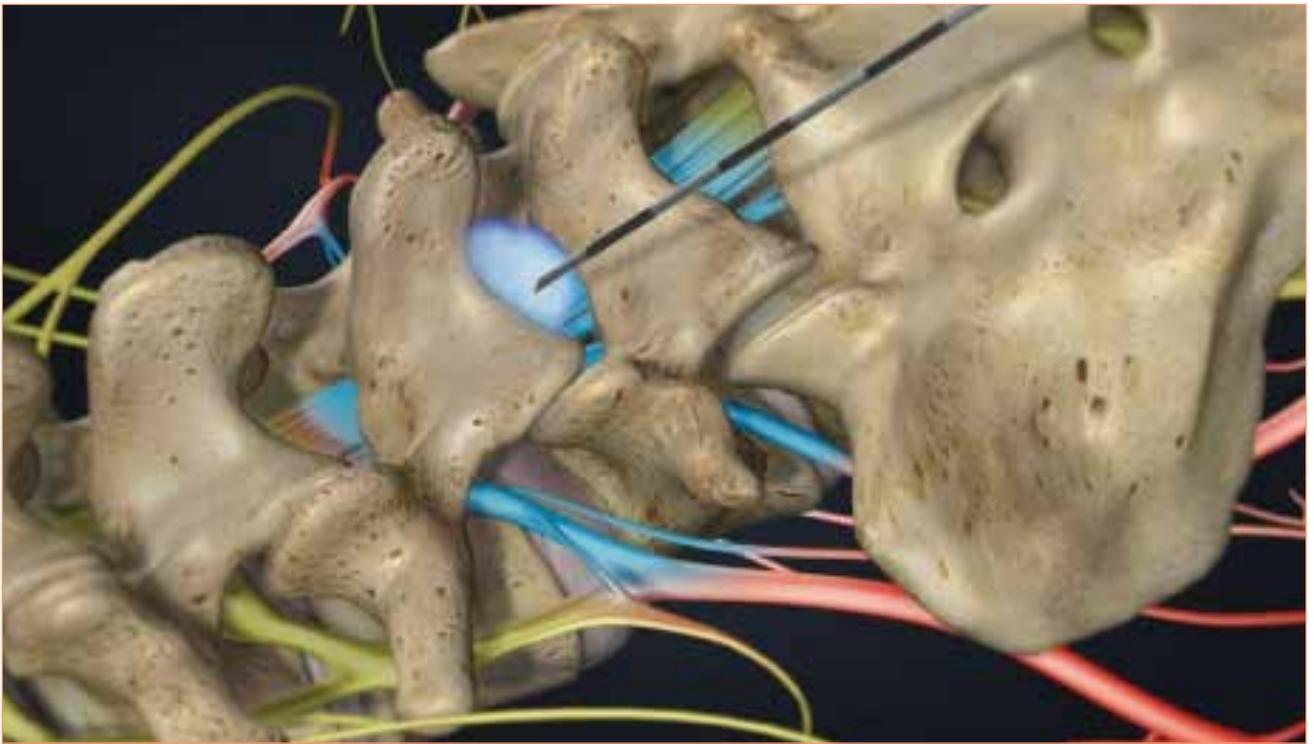
The primary focus of this journal course update is to understand how technique and selection of specific corticosteroids used for epidural steroid injection (ESI) can effectively help in the management of chronic back

and radicular pain while minimizing risk that leads to unnecessary harm.

## Epidural Steroid Injections

The first recorded injection of a corticosteroid solution into the epidural space was in 1952 by Robecchi and Capra<sup>8</sup> and was documented in the European medical literature. The following year, Lievre and colleagues<sup>9</sup> published an article documenting the injection of hydrocortisone into the epidural space for the treatment of sciatica in 20 patients. Since that time, the number of publications evaluating the administration of corticosteroid solutions administered in the epidural space has increased substantially, and many who specialize in the field of pain medicine routinely perform ESIs when the clinical presentation, physical examination results, and radiographic findings indicate their use.<sup>10</sup> Epidural steroid injections are considered a second-line therapy and are usually reserved for those in whom initial conservative treatment has failed.<sup>10</sup> Conservative treatment may include both pharmacologic and nonpharmacologic measures.

The evidence regarding the benefits of ESIs has been highly variable, and the evaluation of outcomes can be diverse. Outcome assessments from ESIs have included functional outcomes, health status measures, quality of life measures, medication use, (short- and long-term) depression inventories, and pain assessments (short- and long-term) with a variety of different instruments.<sup>4</sup> Several reviews of trials of ESIs suggested that the early studies had methodologic problems.<sup>2</sup> Despite the challenges with appropriate scientific evaluation of the evidence regarding ESIs, it continues to be performed routinely, and many individuals have benefited substantially from only one or from repeated injections.<sup>11</sup> Interestingly, the US Food and Drug Administration (FDA) has not approved a single corticosteroid solution for injection in the epidural space. The FDA warns that the epidural injection of a corticosteroid solution may result in rare but serious adverse events, including loss of vision, stroke, paralysis, and death. This warning has been attached to the labels of some injectable corticosteroid solutions.<sup>10,12,13</sup>



**Figure 1.** Traditional Interlaminar Approach to Epidural Steroid Injection

### Approach to the Epidural Space

The approach selected by the interventional pain management provider to access the epidural space may greatly impact the distribution of the corticosteroid solution to the desired location. Most anesthesia providers are familiar with the traditional IL approach and caudal approach to access the epidural space to administer medication or placement of a catheter. The IL approach accesses the epidural space through either a midline or paramedian technique and involves advancing the needle between adjacent spinal laminae through the ligamentum flavum into the posterior epidural space using the classic loss of resistance technique (Figure 1). It is specifically indicated for treatment of radicular pain, typically for bilateral and/or multilevel symptoms.<sup>13-15</sup> This approach is commonly used in the lumbar, thoracic, and cervical regions of the vertebral column.

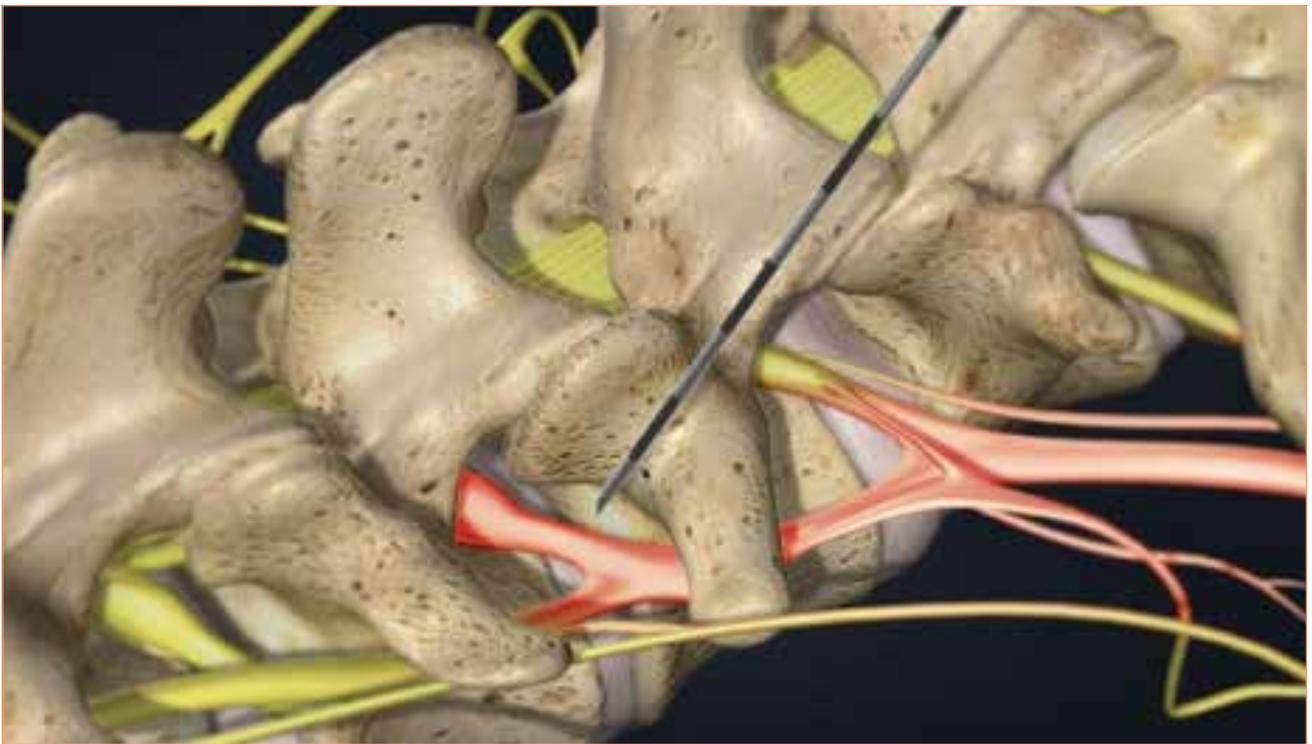
The TF approach is not traditionally taught in anesthesia training programs, but it is part of the subspecialty training in advanced and interventional pain management. The TF ESI preferentially delivers medication to the anterior epidural space in which the needle is advanced into the intervertebral neuroforamen (Figure 2). This approach must be performed under fluoroscopic or radiologic image guidance.<sup>11,13,16</sup> Corticosteroid solutions are placed at the suspected pathologic site correlating with clinical presentation. This approach is commonly used in the lumbar and sacral areas of the vertebral column.<sup>14(p)</sup> There are specific indications and guidelines for the TF approach to the epidural space to

minimize risk of complications and maximize safety in appropriately selected patients.

The spinal nerve root exits the narrow neuroforamen on each side of the vertebral column. If the mechanical compression of the nerve root is restricted to one side of the vertebral column it is possible that a midline IL approach may not be the most appropriate and effective. Disks can protrude or extrude into the (1) postcentral, (2) lateral or exit zone, or (3) far lateral zone. The recommended treatment will vary with the type and level of disk pathology and clinical presentation. A postcentral disk will most likely trap the inferior nerve root, a lateral disk may affect the nerve root at that spinal level, and both abnormalities may benefit from an IL approach. The far lateral disk may be more amendable to the TF approach directed to the side where the compression exists.<sup>17</sup>

The caudal approach to the epidural space is one of the oldest techniques used in anesthesia. A caudal ESI is used to treat lower back pain and is indicated for radicular symptoms with a lumbosacral cause. A needle is advanced through the sacral hiatus to access the epidural space (Figure 3). This is an optional approach in patients with a history of lumbar spine surgery, especially when single and multilevel TF may be required, and contrast flow is unable to reach site of pathology.<sup>14(p)</sup>

Interventional approaches for back pain with subsequent administration of corticosteroid solutions are to be performed with the use of radiologic image guidance, most commonly in the form of fluoroscopy. This is the standard of care and requires advanced training in these



**Figure 2.** Transforaminal Approach to Epidural Steroid Injection



**Figure 3.** Caudal Approach to Epidural Steroid Injection

techniques in addition to radiation safety.<sup>13,16</sup> The use of fluoroscopy and the performance of radiologic procedures are regulated by multiple offices and administrative codes at the state and national levels. Therefore, those practicing interventional approaches in pain management must be

familiar with these regulations and practice accordingly.

### **Complications Associated With Epidural Steroid Injections**

Epidural steroid injections are considered safe and effec-

tive treatment strategies for the treatment of radicular pain. Complications are rare and generally categorized as being (1) approach related (caudal, IL, or TF); (2) related to needle trauma (direct neural injury or postdural puncture cerebrospinal hypotension); (3) vasospastic or ischemic (anterior spinal artery syndrome); (4) infectious (epidural abscess, meningitis, diskitis); (5) related to the drug injected; or (6) related to the drug diluent or additives.<sup>2,18,19</sup> Minor complications and side effects do not involve permanent impairment and may include exacerbation of pain, vasovagal reactions, headache, and unintentional dural puncture.<sup>19-21</sup> However, rare neurologic injuries as a result of ESIs can be catastrophic and result in severe permanent disability, spinal cord injury, loss of vision, stroke, or death.<sup>2,18-21</sup> Evidence associated with catastrophic injuries have been described in the media, case reports, closed malpractice claims, and FDA reports. It is hypothesized that many of the catastrophic complications are embolic in nature and related to the particulate size of the corticosteroid solution injected.<sup>13,15,22</sup>

### Corticosteroid Pharmacology

Corticosteroids are key mediators in the maintenance of normal physiology and homeostasis and form complex adaptive protective mechanisms in the setting of internal and/or external stressors. Corticosteroids affect almost all organ systems, and their effects include alterations in carbohydrate, protein, and lipid metabolism; maintenance of fluid and electrolyte balance; and preservation of the cardiovascular, immune, renal, endocrine, and nervous systems and skeletal muscle.<sup>2,20,23</sup>

All corticosteroids are produced in the cortex of the adrenal gland, which is composed of 3 distinct zones.<sup>2,23</sup> The outer zone, the zona glomerulosa, produces mineralocorticoids, specifically aldosterone, which is synthesized in response to stimulation by the renin-angiotensin-aldosterone system or in the presence of hyperkalemia. The middle zone, the zona fasciculata, is the site of glucocorticoid production. Cortisol is the main glucocorticoid under the control of the hypothalamic-pituitary-adrenal (HPA) axis and represents about 80% of glucocorticoid production. The inner zone, the zona reticularis, produces glucocorticoids and small amounts of androgens. Naturally occurring or endogenous corticosteroids are classified into these 3 functional groups: glucocorticoids, mineralocorticoids, and adrenal androgens.<sup>2,23</sup> This Journal course will focus on glucocorticoids.

Cortisol is secreted at a rate of approximately 10 mg/d, and synthesis depends on 3 factors: negative feedback by serum cortisol levels, normal circadian cycle, and central nervous system activation in response to stress.<sup>2,23</sup> Glucocorticoids act primarily to enhance the production of high-energy fuels, glucose, and reduce other metabolic activity. They stimulate hepatic gluconeogenesis, increase hepatic glycogen content, inhibit

insulin-mediated peripheral blood glucose uptake, and regulate lipid metabolism resulting in lipolysis. These actions vary in different parts of the body. One example is cortisol, which can deplete the protein matrix of the vertebral column with minimal effect on the long bones. Cortisol maintains vascular responsiveness to circulating vasoconstrictors (renin-angiotensin-aldosterone system) in high doses and may restore circulatory function in shock (hemorrhage, endotoxin, anaphylaxis, and trauma). Additionally, it maintains the microcirculation in the setting of acute inflammation by reducing capillary endothelial permeability and preventing edema formation.<sup>2,23</sup>

### Corticosteroids and Pain

Corticosteroids are predominantly administered as part of interventional pain management strategies because of their proven anti-inflammatory effects with subsequent relief of symptoms. They are among the most frequently prescribed, potent and effective agents in controlling inflammation. Analgesia is obtained primarily through direct anti-inflammatory effect, cell membrane stabilization, and possibly neurolysis of unmyelinated C fibers.<sup>2,23-25</sup> Anti-inflammatory effects include maintaining microcirculation at the site of inflammation by reducing capillary endothelial permeability, preventing edema formation as well as immune response modulation, which has been implicated in chronic pain. Additionally, corticosteroids inhibit the phospholipase enzyme that is necessary for inflammatory chain reaction along both the cyclooxygenase and lipoxygenase pathways.

Toxic effects may result from the therapeutic use of corticosteroids. Abrupt withdrawal may result in acute adrenal insufficiency. Alternatively, continued use of supraphysiologic doses may result in fluid and electrolyte abnormalities, hypertension, hyperglycemia, increased susceptibility to infection, osteoporosis, myopathy, behavioral disturbances, cataracts, growth retardation, and the characteristic habitus including fat distribution, striae, and ecchymoses.<sup>2,23</sup>

The most commonly used synthetic corticosteroids for interventional pain procedures are derivatives of prednisolone, an analog of endogenous cortisol. These medications are produced either by the process of methylation (methylprednisolone) or fluorination (triamcinolone, betamethasone, and dexamethasone). These 4 corticosteroids differ in particulate size, potency, half-life, relative glucocorticoid and mineralocorticoid activity, glucocorticoid dose equivalency and relative anti-inflammatory activity (Table). Endogenous cortisol has a ratio of 1:1 mineralocorticoid-to-glucocorticoid activity and a half-life of 70 to 90 minutes, whereas all synthetic analogs of cortisol have longer half-lives based on their slower rates of metabolism. Hydrocortisone is the exogenous gold standard when it comes to ratio comparison to cortisol.<sup>2,23,25</sup>

Corticosteroid	Half-life, h	Relative glucocorticoid activity	Relative mineralocorticoid activity	Glucocorticoid dose equivalency	Percent particle size < 10 µm <sup>a</sup>	Percent particle size > 10 µm
Methylprednisolone	18-36	5	0.5	4	60	40
Triamcinolone	18-36	20-30	0	4	71	29
Dexamethasone	36-54	20-30	0	0.75	0	0
Betamethasone	36-54	1	0	0.6	61	39

**Table.** Relative Potency of Corticosteroids Used in Chronic Pain

<sup>a</sup>Modified from Benzon et al.<sup>27</sup>

(Modified from Jacobs JW, Bijlsma JW. Glucocorticoid therapy. In: Firestein GS, Budd RC, Gabriel SE, McInnes IB, O'Dell JR, eds. *Kelley and Firestein's Textbook of Rheumatology*. 2017:932-957.e5.)

## Commercial Corticosteroids: Particulate Versus Nonparticulate

Commercially available corticosteroids are broadly categorized into particulate or nonparticulate solutions (see Glossary). Particulate corticosteroids contain water-insoluble corticosteroid esters and appear as microcrystalline suspensions. Conversely, nonparticulate corticosteroids are free of corticosteroid esters and appear as clear solutions. Particulate vs nonparticulate categories are largely based on the corticosteroid particle size and aggregation compared with the size of a red blood cell (RBC) via light microscopy data.<sup>22</sup> Specifically, if a corticosteroid particle is larger than an RBC (typical diameter is 6-8 µm), it is generally considered a particulate steroid. Theoretically, particles smaller than an RBC would decrease the risk of an embolic infarction with an inadvertent intravascular injection.<sup>22,26</sup> In one investigation using light microscopy, researchers compared particulate size of corticosteroids and established that methylprednisolone had the largest particles, triamcinolone had intermediate-sized particles, and betamethasone had the smallest particles of the commercially available particulate steroids.<sup>2,13,22,26</sup> It is critical to note that these particles or their aggregates can potentially act as emboli if inadvertently injected into an artery. Preparations with large particulate sizes have been associated with greater morbidity.<sup>2,13,15,22</sup> Particulate size is directly related to half-life, which appears to be a motivating factor for providers when they select a particulate steroid solution over a nonparticulate steroid solution. Dexamethasone does not form particles or aggregates and is considered the only commercially available nonparticulate corticosteroid.<sup>2,13,26,27</sup>

- **Methylprednisolone.** Methylprednisolone is a particulate steroid commercially prepared as Depo-Medrol/Solu-Medrol. It is known to have a maximum particle size greater than 500 µm. One investigation using a rat model intentionally injected methylprednisolone into the carotid artery and produced severe neurologic injuries that included cerebral hemorrhage and stroke.<sup>28</sup> In a similar investigation using swine as the model, intentional injection of methylprednisolone into the vertebral

artery produced brainstem edema and ischemic brain damage, and resulted in the inability to regain consciousness.<sup>29</sup> A similar sequence of events is described in case reports when particulate corticosteroids are inadvertently injected into the cerebral circulation in human beings and resulted in catastrophic outcomes.<sup>30-32</sup> In contrast, when investigations used animal models with similar methods, an injection of dexamethasone into the cerebral circulation did not result in the same extent of catastrophic injuries.<sup>2,28,29</sup> In 2012, an outbreak of fungal infections (*Exserohilum rostratum*) from epidural injections of contaminated compounded methylprednisolone occurred.<sup>19,33,34</sup> These preparations can also contain polyethylene glycol and the preservative benzyl alcohol, which may be neurotoxic.<sup>2,19,22,23,26</sup>

- **Triamcinolone.** Triamcinolone (eg, Kenalog) is a particulate steroid. It is known to have the maximum particle size greater than 500 µm and has been associated with reported spinal cord infarct leading to C3 quadriplegia, cerebellar infarct, T10 paraplegia, and at lower levels L2 paraplegia.<sup>2,30,32,35,36</sup> In addition to the dangers associated with particulate size, triamcinolone has also been associated with Cushing syndrome and steroid myopathy of the proximal muscles of the lower extremity; both occurred after a single epidural triamcinolone acetate injection.<sup>2,16</sup> Further case reports suggest epidural injections of triamcinolone have led to marked reduction in insulin sensitivity in patients with normal glucose tolerance and caused fasting hyperglycemia in patients with a preexisting degree of insulin resistance.<sup>2,19</sup> Like methylprednisolone, triamcinolone contains polyethylene glycol and the preservative benzyl alcohol, which may be neurotoxic.<sup>2,19,22,23,26</sup>

- **Betamethasone.** There are 2 betamethasone preparations: betamethasone acetate (practically insoluble) and betamethasone sodium phosphate (freely soluble). A commercial preparation of betamethasone is Celestone Soluspan, which is a combination of the 2 preparations.<sup>23</sup> Although betamethasone particulate size is smaller than methylprednisolone or triamcinolone, at least one case report of L1 paraplegia due to spinal cord edema has been linked to its use.<sup>2,19</sup> Betamethasone sodium phosphate

is considered a soluble compound, it does not contain either polyethylene glycol or benzyl alcohol, and there are recommendations for its use when a nonparticulate corticosteroid is indicated.<sup>2,22,23,27</sup>

• **Dexamethasone.** Preservative-free dexamethasone (eg, Decadron phosphate) is freely soluble, does not contain either polyethylene glycol or benzyl alcohol, and is considered a nonparticulate corticosteroid with minimal particle aggregation.<sup>2,22,23,27</sup> It has not been associated with major neurologic complications and appears to have a better safety profile compared with other corticosteroids used for epidural injections. Preservative-free dexamethasone is reported to be long-acting with minimal mineralocorticoid activity. It has increased glucocorticoid activity, so increased blood glucose levels are possible. Concerns regarding equipotency and effectiveness of using only a nonparticulate steroid in a population of patients with chronic pain have been voiced. In theory, soluble nonparticulate corticosteroids are washed out of their targeted region more readily. They may not reduce the inflammation and produce the long-term relief that one might expect with an insoluble particulate steroid.<sup>22</sup> However, investigations comparing triamcinolone with dexamethasone for major joint injections have demonstrated no statistically significant difference between onset, duration, or efficacy.<sup>22</sup> In 2013, dexamethasone was demonstrated to be noninferior to the particulate steroids when the investigators compared pain relief and functional improvement at 2 months, and when they accounted for potency equivalence.<sup>37</sup> In 2015, an expert panel from 13 national specialty stakeholder societies agreed that the nonparticulate steroid dexamethasone should be used for the initial injection in lumbar TF epidural injections but may be followed with particulate steroids for subsequent injections, even if initial injection therapy failed.<sup>13</sup>

## Discussion

Many investigations have evaluated the size and aggregation of corticosteroids while comparing the effectiveness of particulate vs nonparticulate solutions. In 2007, Benzon and colleagues<sup>27</sup> compared the particles of methylprednisolone, triamcinolone, betamethasone, and dexamethasone in both diluted and undiluted samples. At that time, they did not recommend the routine use of dexamethasone without further study of its safety and efficacy. However, they did recommend commercially prepared betamethasone when an insoluble steroid is preferred.<sup>27</sup> In 2008, Derby and colleagues<sup>26</sup> evaluated particulate size and aggregation of 4 types of corticosteroid preparations: dexamethasone sodium phosphate, triamcinolone acetonide, betamethasone sodium phosphate, and methylprednisolone acetate. The dexamethasone sodium phosphate particle size was approximately 10 times smaller than the red blood cells, and the

particles did not appear to aggregate. Dexamethasone sodium phosphate had the lowest density, which would significantly reduce the risk and prevent embolic infarcts after an intra-arterial injection. The authors concluded that spine interventionalists should consider using dexamethasone when performing ESIs.<sup>26</sup>

Results from investigations are mixed regarding the comparative effectiveness of particulate vs nonparticulate corticosteroids. Traditional belief is that particulate steroid solutions when administered in the epidural space, using appropriate and accepted techniques, will provide longer durations of pain relief compared with the nonparticulate solution. Interestingly, most early investigations that established the efficacy of the ESI primarily used particulate corticosteroids. It is generally accepted these studies had methodologic problems.<sup>13,22</sup> There are many challenges with appropriate scientific evaluation of the evidence regarding ESIs. Knowledge and technology regarding interventional strategies continue to advance at a rapid rate. Findings from investigations 10 years ago may no longer be considered fair comparisons in 2018.

Results of more recent investigations suggest that the comparative effectiveness of dexamethasone compared with particulate steroids may not be as great as previously believed. In 2013, a retrospective observational study that included a noninferiority analysis of dexamethasone relative to particulate steroids demonstrated no evidence of decreased effectiveness in lumbar TF ESIs performed for radicular pain with or without radiculopathy.<sup>37</sup> In 2014, a prospective randomized double-blind trial was conducted to evaluate the differences in effectiveness between particulate and nonparticulate corticosteroids for acute radicular pain due to lumbar disk herniation.<sup>11</sup> The investigators concluded that epidural corticosteroid injections are an effective treatment of acute radicular pain associated with disk herniation, and pain symptoms improved with only 1 or 2 injections. Dexamethasone appeared to possess reasonably similar effectiveness but did require slightly more injections to achieve the same outcomes. Slightly more than 17% of the dexamethasone group received 3 injections vs 2.7% of the triamcinolone group.<sup>11</sup>

There are no corticosteroids currently approved by the US Food and Drug Administration (FDA) for injection into the epidural space of the spine. The FDA provides a warning that epidural injection of corticosteroids may result in rare but serious adverse events, including loss of vision, stroke, paralysis, and death, necessitating the addition of a warning label for injectable corticosteroids.<sup>12,13</sup> As a result of collaboration between the FDA and selected specialty stakeholders, safeguards were developed to prevent neurologic complications after ESI. The unanimous consensus opinion is that ESIs are safe and should be performed with image guidance using all necessary safety precautions. Readers are encouraged to review "Safeguards to Prevent Neurologic Complications

after Epidural Steroid Injections: Consensus Opinions from a Multidisciplinary Working Group and National Organizations,” published as a special article in the May 2015 issue of *Anesthesiology*.<sup>13</sup> There is unanimous agreement that the choice of technique should be individualized balancing risks vs benefits.

Those who provide ESIs should be aware of the distinctions between corticosteroids with regard to relative mineralocorticoid and glucocorticoid activity, relative potency, duration, half-life, and particulate size when considering treatment options. Anatomical considerations, light microscopy data, case reports of complications, and comparative effectiveness are all part of the clinical decision-making process. The authors strongly suggest that those providers who perform ESIs carefully review the most recent literature. Safeguards and guidelines have been established to manage chronic pain safely and effectively, while minimizing risk and reducing unnecessary harm.

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