July 29, 2015

Elise Berliner, PhD
Director, Technology Assessment Program
Center for Outcomes and Evidence
Agency for Healthcare Research and Quality
540 Gaither Road
Rockville, MD 20850

Dear Dr. Berliner:

The recent publication of the Agency for Healthcare Research and Quality's (AHRQ) Technology Assessment *Pain Management Injection Therapies for Low Back Pain* has raised significant concerns for physicians who utilize injection procedures to treat patients suffering with pain and functional limitations resulting from spinal pathology. Representatives of 14 medical specialty societies representing both physicians who perform these procedures and those whose practices rely on them in determining appropriateness of more invasive surgical treatments have convened to discuss concerns and formulate an appropriate response. The medical specialty societies who participated in this review and critique share a common goal with the AHRQ: commitment to identifying pain management therapies that provide value to the patient and society through measurable improvements in pain and physical functioning with no or minimal adverse events.

We are fully cognizant of the issues of overutilization and inappropriate utilization, and therefore also wish to bring into focus which interventions are effective when treating the various causes of low back pain. We have concerns, however, that the methodology employed by the report's authors cannot and does not make such determinations, and that the conclusions may lead to egregious denial of access to these procedures for many patients suffering from low back pain. We trust that due consideration will be given to the most critical comments made during the peer review/public comment period and that several aspects of the report will be revisited to ensure that the best available evidence is addressed scientifically in order to provide an accurate assessment of the procedures reviewed.

Our primary concerns fall into five main categories, and are best illustrated by the flawed epidural steroid analysis:

- Assertions Regarding the Nonspecific Nature of Axial and Radicular Pain
- Evidence Base Restriction to Randomized Controlled Trials (RCTs)
- Inadequate Analysis of Patient Selection
- Inadequate Analysis of Technical Procedural Performance
    - Subgroup Analysis by Image Guidance
    - Subgroup Analysis by Epidural Access
    - Failure to properly assess quality of trials by emphasis solely on research methodology
- Inadequate Data Analysis: Emphasis on Continuous, not Categorical Data

**Nonspecific Nature of Axial and Radicular Pain**

The authors begin with the assertion that injection therapies for "low back pain" are directed toward a nonspecific and un-diagnosable process. They used this fundamentally false assumption to justify their inclusion of trials with patient selection based on symptoms, not a specific diagnosis. The authors state in the draft report: "In the majority (>85%) of patients with low back pain, symptoms cannot be attributed to a specific disease or spinal pathology." They cite their review paper from 2002 that contains no primary data. The original source of this statement was a synopsis of a workshop on idiopathic low back pain from 1982. (1) That article was not an original research study, contained no original data or further references, and appears to have been a piece of expert opinion at best. In that article from 1982, the authors noted that previous estimates of low back pain without definite etiology range widely from about 20% to 85%. Thus, in an effort to justify their approach to include trials that selected patients by symptoms rather than specific diagnoses, the authors of the AHRQ report misquoted a 30 year-old opinion piece. They relied on a manuscript that predates both modern MRI scanning and the current use of image-guided diagnostic injections, both of which have been repeatedly shown to be valuable in the diagnosis of spine pathology.

In the final, published report, the 85% figure remains, but the citation has been changed to a paper that addresses the lack of specificity of spine imaging, a well-known observation that is not relevant here. When challenged during peer review/public comment, the authors' response indicated that the non-attributable nature of low back pain is acknowledged in the guidelines of the American College of Physicians, and no evidence is necessary, as there can be no evidence due to the lack of a pathoanatomic reference standard. The authors are correct that a pathoanatomic criterion standard is lacking for all studies ever conducted with pain as a primary variable. That nihilism, however, is not part of clinical practice. Systematic application of controlled anesthetic blocks or provocation procedures can achieve somewhat less sensitive, but far more specific diagnosis than simply relying on symptoms. Radiculopathy has specific observable physical examination and electrophysiologic findings. Radicular pain without radiculopathy can be diagnosed by a combination of physical exam (e.g. straight leg raising test) and controlled selective nerve blocks. Somatic axial pain experienced in the lumbar region can be specifically attributed to the facet joints (dual comparative medial branch blocks), the intervertebral disc (disc stimulation), paraspinal muscles and fascia (trigger point injections), or the sacroiliac joint (controlled intra-articular blocks and multi-site, multi-depth lateral branch blocks). Numerous studies over the past 20 years have established prevalence rates for these specific pain generators and their relationship to age and gender. (2-8) We feel it is inappropriate to ignore this body of evidence and accept trials whose inclusion criteria are mere symptoms. The authors of the technology assessment should not be allowed to use, as a foundation of their methodology, 85% as the level of non-attributable symptoms in low back pain, as this is based on either pure assertion or 30-year-old "expert" opinion.

**Evidence Base Restriction to Randomized Controlled Trials (RCTs)**

The efficacy of injection therapies for radicular pain has been the subject of a great deal of research effort that is totally ignored in this assessment. The inclusion criteria of the report select for research methodology: randomized controlled trials (RCTs) of injection therapies versus placebo, randomized comparative effectiveness trials, and large observational trials only with respect to harms. The exclusion of high quality observational studies of clinical effectiveness removes important information and context from a synthesis of the literature. The authors state

that there are ample RCTs for analysis, and examination of observational trials is unnecessary. However, many of the RCTs included patients selected only by symptoms or fail to utilize image guidance. These failings, further discussed below, make such trials irrelevant to current clinical practice and not unexpectedly show poor outcomes. Judging current practice of precise needle placement to a 1 - 2mm target zone in three dimensional space with confirmation of medication distribution by real-time observation of contrast flow by using data from blind injections into an unknown tissue compartment has no validity. There are very few RCTs that utilize current practice standards -- only the Ghahreman study is truly representative. (9) Hence examination of current large observational studies adds important information that is relevant to current standards of practice.

**Inadequate Analysis of Patient Selection: Subgroup Analysis by Specific Diagnosis**

Many of the studies in the analysis fail to adequately specify the process under treatment. There is no physiologic process beyond systemic effect by which steroids delivered to the epidural space would be expected to affect axial back pain arising from nociception in the intervertebral disc, facet joints, sacroiliac joint, or supporting musculature. There is ample experimental and clinical evidence that radicular pain has an inflammatory basis and is potentially susceptible to targeted delivery of an anti-inflammatory agent to the interface of neural tissue and the compressive lesion. (10) Many of the included studies have treated an undefined mix of axial and radicular pain patients; heterogeneity of response is therefore expected, not surprising. The specificity of the diagnosis in the study populations was not included in the assessment of study quality.

An RCT without careful patient selection is of no clinical value and may be misleading, yet its RCT methodology tends to purchase it credence. Examining the 29 studies of "epidural steroid injection" versus placebo, radicular pain alone was specified in 22, a mixture of radicular and back pain in six, and back pain alone in one. A correlative imaging finding was required for inclusion in only 11 of 29 studies. The nature of the conditions being treated in this heterogeneous group of studies is thus largely unknown, and the degree of neural compression is completely unknown. Two independent studies have provided correlative data demonstrating the degree of neural compression is a predictor of successful clinical response to transforaminal epidural steroid injections (TFESI). (11,12) With minimal neural compression, the proportion of responders may be as high as 75%; with high grade compression, the response rate may be as low as 25%. The lack of diagnostic specificity in patient selection is unfortunately emphasized by the lack of clarity in the title of this technology assessment. Here "low back pain" is deemed inclusive of axial pain, radicular pain without radiculopathy, and true radiculopathy with a neurologic deficit. The definitions used by the authors are at variance with accepted medical terminology within neurology and pain management standards of care. (13)

For perspective, consider a hypothetical systematic review of prescription medication for the treatment of cough, a common symptom like low back pain. Studies may show beneficial effects from antibiotics in a group of patients with bacterial pneumonia, a specific diagnosis, whereas pooled data from heterogeneous groups of patients with cough– including viral bronchitis, chemical pneumonitis, asthma, lung cancer, *etc.* – would produce different effects. If these pooled effects showed that many different medications had minimal impact on cough from various sources, would we abandon prescription antibiotics for pneumonia?

Additionally, the identification of the underlying etiologies of pain is essential as different pathologies not only have varying responses to treatment, but also have different natural histories, impacting prognosis. Thus, the time frame of follow-up to determine clinical utility becomes imperative. Some conditions, such as intervertebral disc herniation, can result in debilitating pain, but have an overall favorable natural history. This would be in contrast to neurogenic claudication due to central canal stenosis, which is less likely to resolve spontaneously with time. Thus short-term relief, as noted by the authors of the AHRQ report, would be very appropriate and expected for a disc herniation. To evaluate the long-term effects in this population would be as flawed as evaluating the long-term effectiveness of antibiotics for pneumonia. Again, should we withhold all antibiotics for pneumonia given the largely favorable natural history, or should we state antibiotics are ineffective because all subjects were better at 1 year follow-up? Similarly, should we withhold pain medications from patients with fractures or after orthopedic surgery, as these conditions only result in pain and have favorable natural histories?

**Inadequate Analysis of Technical Procedural Performance:**
**Image Guidance and Contrast Confirmation of Epidural Spread**

The techniques utilized in the administration of epidural steroids are also critical. No randomized studies examined the use of image guidance as a variable. This has, however, been well examined in non-randomized studies demonstrating that up to 74% of "epidural" steroid injections performed without image guidance either deposit medication external to the epidural space or do not reach the targeted pathology within the ventral epidural space. (14-17). Examining the 29 studies used to assess efficacy of epidural steroid injections versus a placebo, there were 15 interlaminar or presumed interlaminar epidural steroid injection (ILESI) studies, of which only one used fluoroscopic guidance. There were nine caudal injection studies, of which only a single study reported fluoroscopic guidance. Five transforaminal epidural steroid injection (TFESI) studies all utilized fluoroscopic guidance. Hence, with the exception of the five TFESI trials, the studies of "epidural steroid injections" deposited an anti-inflammatory agent into an unknown tissue space from which the agent was unlikely to reach the site of inflammation. Although there were no randomized studies with image guidance as a primary variable, it is reasonable to compare explanatory trial data. Data from explanatory trials of non-image guided injections yields a number needed to treat (NNT) greater than 90. (18-22) In contrast, a high quality explanatory trial of image-guided TFESI yields a NNT of 3. (9)

It is the position of the Multisociety Pain Workgroup that image guidance is absolutely essential for the safe and efficacious performance of epidural procedures, based on a large body of non-RCT evidence. It is, in fact, impossible to affirm the successful performance of a TFESI without image guidance. The AHRQ report's sole reliance on RCTs and failure to acknowledge the context provided by the past 20-30 years of well-performed observational studies places AHRQ in the absurd position of denying the relevance of image guidance, which is the basis for a large body of medical practice. It also places AHRQ in conflict with the Food and Drug Administration's Safe Use Initiative, which recommends image guidance for epidural steroid injections of all types. (23)

**Inadequate Analysis of Technical Procedural Performance:**
**Subgroup Analysis by Epidural Access**

While image guidance is essential, the technique of delivery is equally important. Most of the ILESI and caudal injection studies cited in the technology assessment suffer from the lack of image

guidance; the ILESI technique in these outdated and essentially irrelevant studies was a midline approach. Even when performed with image guidance these procedures may deliver medication distant from the site of pathology, without certainty that the steroid will reach, or in what concentration it will reach, the target zone in the ventral epidural space. In contrast, TFESI procedures place the needle in direct proximity to the target nerve and verify delivery to that site by observing contrast media flow. (24) Recently described lateral parasagittal ILESI have also been shown to preferentially deliver injectate to the target ventral epidural space. (25) It is not reasonable to combine these injection techniques in an evaluation of "epidural steroid injections".

As epidural access techniques are quite different in the likelihood of delivering corticosteroid to the ventral epidural space and specific nerve roots, it is essential to consider whether there are differences in outcomes. The technology assessment makes that determination based on five randomized comparative effectiveness studies examining differences between TFESI and midline ILESI, without consideration of lateral parasagittal ILESI. Using pooled continuous data, the report concludes that there were no differences in pain relief or functional recovery at immediate or short term, and no difference in pain relief at intermediate term using weighted means. However, looking at the studies individually, a study of TFESI versus midline ILESI versus caudal injections in patients with radicular pain and correlative imaging, using the same steroid doses, showed significantly greater proportions of TFESI patients achieving a categorical outcome for pain relief with significantly lower levels of pain at 24 weeks than ILESI or caudal injections. (24) TFESI delivered the medication to the ventral epidural space at the target segment significantly more often, which correlated with improved pain outcomes. Another study showed significantly greater improvements in pain relief and functional recovery at 6 months for TFESI vs. ILESI without image guidance. (26) The technology assessment fails to mention the RCT demonstrating that lateral parasagittal ILESI have significantly better outcomes for pain relief at 6 months when compared with midline ILESI. (25) It also fails to note the RCT that shows essential equivalence in outcomes between TFESI and lateral parasagittal ILESI, where both provided ventral epidural flow. (27) The critical clinical point is whether the delivered agent reaches the target tissue in the ventral epidural space, not necessarily the access route of the needle. Aggregating midline ILESI and caudal injections with lateral parasagittal ILESI and TFESI in an artificial category of "epidural steroid injections" is not justified.

The methodological flaw of relying exclusively on RCT data and creating an artificial category of "epidural steroid injections" is brought into focus by examining a broader synthesis of the data supporting TFESI. The most rigorously controlled trial supporting the efficacy of TFESI in patients with radicular pain due to disc herniations compared transforaminal steroids with four control arms using categorical outcomes of greater than or equal to 50% pain relief at 1 month. (9) Note that this trial required a correlative lesion on imaging; it is incorrectly declared in the AHRQ assessment that it did not do so. Transforaminal injection of steroid produced 54% (95% CI: 36-72%) responders, significantly greater than the control arms, which were indistinguishable from one another (15% responders, 95% CI: 8-22%). All patients who were relieved of their pain were restored to normal or near normal function and reduced their need for other health care. All patients previously requiring opioids ceased opioids. These significant outcomes with direct population health implications were concealed in the AHRQ's assessment by inclusion only of continuous data (group means).

Another controlled trial used surgical sparing as the primary outcome. Only 29% of patients required surgery after treatment with transforaminal steroids injections compared with 67% treated with transforaminal local anesthetic. (28) The effects were durable in a 5-year follow-up study of these patients. (29) A recent supportive observational trial studied patients awaiting surgery for radicular pain; 56% (95% CI: 46-66%) avoided surgery after a successful TFESI. (30) A randomized, controlled comparative effectiveness trial of TFESI with two steroid formulations showed that 70% of patients with radicular pain due to disc herniation had greater than or equal to 50% pain relief that was durable at 6 months. (31) Clinical effectiveness of epidural injections was further supported by a large observational study of prospectively collected data on more than 2000 consecutive patients receiving a single TFESI for radicular pain due to disc herniation, fixed lateral recess, or foraminal stenosis. (32) In this study 46% were responders for pain relief (95% CI: 43-49%) and 41% (95% CI: 38-44%) for functional recovery. When patients were segregated by duration of pain syndrome, those with sub-acute pain (< 3 months duration) had 62% (95% CI: 56-68%) responders for pain relief and 59% (95% CI: 53-65%) responders for functional recovery, significantly better than patients with chronic pain. This important, clinically relevant information cannot be derived from the small RCTs included in the AHRQ assessment. The important clinical question of the effectiveness of repeat epidural steroid injections is not addressed by any study with methodology that would qualify for inclusion in the assessment. However, a recent observational study of prospectively acquired data on over 2000 TFESI in 933 patients demonstrated that repeat TFESI are less effective than an index TFESI, although not by a clinically relevant amount. More responsive sub-acute pain patients recovered all prior benefit in pain relief from an index injection that had since waned; early repeat injections for incomplete responders provided cumulative benefit. (33) A systematic review synthesized all the evidence from six explanatory trials, 11 pragmatic trials, and 20 observational studies of lumbar TFESI and concluded that up to 70% of patients with radicular pain due to disc herniations achieve 50% pain relief at 1-2 months after treatment and 30% achieve complete relief. Between 25% and 40% of patients have relief that lasts 12 months. (34)

**Inadequate Data Analysis: Emphasis on Continuous, Not Categorical Data**

In addition to image guidance and injection technique, another neglected study characteristic is the method of reporting outcomes data. Many studies included in this analysis report only continuous data as a comparison between group means in reference to a minimum clinically important difference. However, pain and functional disability data are not normally distributed. Rather, responses are often bimodal, with segregation into responder and non-responder populations that will be concealed by evaluating group means. Categorical outcomes that define the proportion of patients reaching a predefined responder status are critical to meaningful interpretation. (35) The authors recognized this and included categorical outcomes when available, but such data often cannot be extracted from the manuscripts, leaving less useful continuous data. In the five trials comparing TFESI and ILESI, only continuous data were analyzed.

**Summary**

It is imperative to recognize that study methodology is meaningless unless the procedures being assessed are performed on appropriately selected patients with appropriate indications using accurate and current technique. An RCT with sound randomization, excellent blinding, and no losses to follow-up is of no value if the patients did not have the condition under investigation and/or the therapeutic procedure was not conducted accurately. Stratification of studies by acceptable, technical performance of the procedures is critically important and must be

considered in parallel with, or even precede, evaluation of study design in assigning value to a study. The Ghahreman trial applied such technical rigor in procedural performance, as the procedures were performed in accordance with the very specific Practice Guidelines for Spinal Diagnostic and Treatment Procedures of the International Spine Intervention Society. (9) This study alone, of all the RCTs addressing epidural steroid injections, reasonably reflects current clinical practice. It is supported by a large body of prospectively acquired data in outcomes studies ignored by this report that also utilized well selected patients and careful control procedures.

Thank you for considering our comments, which are offered in the spirit of collaboration to ensure an accurate assessment of the injection procedures that can be effective tools in the treatment of appropriately selected patients.

Sincerely,

American Association of Neurological Surgeons

American Academy of Pain Medicine

American Academy of Physical Medicine and Rehabilitation

American College of Radiology

American Pain Society

American Society of Anesthesiologists

American Society of Neuroradiology

American Society of Regional Anesthesia and Pain Medicine

American Society of Spine Radiology

Congress of Neurological Surgeons

International Spine Intervention Society

North American Neuromodulation Society

North American Spine Society

Society of Interventional Radiology

**References:**


1. White, A. A. & Gordon, S. L. Synopsis: workshop on idiopathic low-back pain. Spine 1982;7:141–149
2. Schwarzer, A.C., Aprill, C.N., Derby, R., Fortin, J., Kine, G., Bogduk, N. The prevalence and clinical features of internal disc disruption in patients with chronic low back pain. Spine 1995;19:1878–1881.
3. Manchikanti, L., Singh, V., Pampati, V., Damron, K.S., Barnhill, R.C., Beyer, C., Cash, K.A. Evaluation of the relative contributions of various structures in chronic low back pain. Pain Physician 2001;4:308–316.
4. Schwarzer, A.C., Aprill, C.N., Derby, R., Fortin, J., Kine, G., Bogduk, N. Clinical features of patients with pain stemming from the lumbar zygapophysial joints. Spine 1995;19:1132–1137.
5. Schwarzer, A.C., Wang, S.C., Bogduk, N., McNaught, P.J., Laurent, R. Prevalence and clinical features of lumbar zygapophysial joint pain: a study in an Australian population with chronic low back pain. Annals of the Rheumatic Diseases 1995;54:100–106.
6. Manchikanti, L., Manchikanti, K.N., Cash, K.A., Singh, V., Giordano, J. Age-related prevalence of facet-joint involvement in chronic neck and low back pain. Pain Physician 2008;11:67-75.
7. Schwarzer, A.C., Aprill, C.N., Bogduk, N. The sacroiliac joint in chronic low back pain. Spine 1995;20:31–37.
8. Maigne, J.Y., Aivaliklis, A., Pfefer, F. Results of sacroiliac joint double block and value of sacroiliac pain provocation test in 54 patients with low back pain. Spine 1996;21:1889–1892.
9. Ghahreman A, Ferch R, Bogduk N. The efficacy of transforaminal injection of steroids for the treatment of lumbar radicular pain. Pain Med 2010; 11 (8): 1149-68.
10. Mulleman D, Mammou S, Griffoul I, Watier H, Goupille, P. Pathophysiology of disk-related sciatica. I. Evidence supporting a chemical component. Joint Bone Spine 2006;73(2):151–8.
11. Ghahreman A, Bogduk N. Predictors of a favorable response to transforaminal injection of steroids in patients with lumbar radicular pain due to disc herniation. Pain Med 2011;12(6):871–9.
12. Choi SJ, Song JS, Kim C, et al. The use of magnetic resonance imaging to predict the clinical outcome of non-surgical treatment for lumbar intervertebral disc herniation. Korean J Radiol 2007;8:156–63.
13. Merskey H, Bogduk N (eds). Classification of Chronic Pain. Descriptions of Chronic Pain Syndromes and Definition of Pain Terms, 2nd edn. IASP Press, Seattle, 1994.
14. Fredman B, Nun MB, Zohar E, Iraqi G, Shapiro M, Gepstein R, Jedeikin R. Epidural steroids for treating "failed back surgery syndrome": is fluoroscopy really necessary? Anesth Analg 1999; 88 (2): 367-72.
15. Bartynski WS, Grahovac SZ, Rothfus WE. Incorrect needle position during lumbar epidural steroid administration: inaccuracy of loss of air pressure resistance and requirement of fluoroscopy and epidurography during needle insertion. AJNR Am J Neuroradiol 2005; 26 (3): 502-5.
16. Botwin KP, Natalicchio J, Hanna A. Fluoroscopic guided lumbar interlaminar epidural injections: a prospective evaluation of epidurography contrast patterns and anatomical review of the epidural space. Pain Physician 2004; 7 (1): 77-80.

17. Weil L, Frauwirth NH, Amirdelfan K, Grant D, Rosenberg JA. Fluoroscopic analysis of lumbar epidural contrast spread after lumbar interlaminar injection. Arch Phys Med Rehabil 2008; 89 (3): 413-6.
18. Dilke TF, Burry HC, Grahame R. Extradural corticosteroid injection in management of lumbar nerve root compression. Br Med J. 1973 Jun 16;2(5867):635-7.
19. Carette S, Leclaire R, Marcoux S, et al. Epidural corticosteroid injections for sciatica due to herniated nucleus pulposus. N Engl J Med. 1997 Jun 5;336(23):1634-40.
20. Breivik H, Helsa PE, Mohar I, Lind B. Treatment of chronic low back pain and sciatica: comparison of caudal epidural injections of bupivacaine and methylprednisolone with bupivacaine followed by saline. In: Bonica JJ, Albe-Fessard D, editors Advances in pain research and therapy. New York: Raven press; 1976.pp. 927-932.
21. Bush K, Hillier S. A controlled study of caudal epidural injections of triamcinolone plus procaine for the management of intractable sciatica. Spine (Phila Pa 1976). 1991 May;16(5):572-5.
22. Valat JP, Giraudeau B, Rozenberg S, et al. Epidural corticosteroid injections for sciatica: a randomised, double blind, controlled clinical trial. Ann Rheum Dis. 2003 Jul;62(7):639-43.
23. Rathmell JP, Benzon HT, Dreyfuss P, Huntoon M, Wallace M, Baker R, Riew KD, Rosenquist RW, Aprill C, Rost NS, Buvanendran A, Kreiner DS, Bogduk N, Fourney DR, Fraifeld E, Horn S, Stone J, Vorenkamp K, Lawler G, Summers J, Kloth D, O'Brien D, Tutton S. Safeguards to prevent neurologic complications after epidural steroid injections: consensus opinions from a multidisciplinary working group and national organizations. Anesthesiology 2015; 122 (5): 974-84.
24. Ackerman WE, 3rd, Ahmad M. The efficacy of lumbar epidural steroid injections in patients with lumbar disc herniations. Anesth Analg. 2007 May;104(5):1217-22
25. Ghai B, Vadaje KS, Wig J, Dhillon MS. Lateral parasagittal versus midline interlaminar lumbar epidural steroid injection for management of low back pain with lumbosacral radicular pain: a double-blind, randomized study. Anesth Analg 2013; 117 (1): 219-27.
26. Thomas E, Cyteval C, Abiad L, et al. Efficacy of transforaminal versus interspinous corticosteroid injectionin discal radiculalgia - a prospective, randomised, double-blind study. Clin Rheumatol. 2003 Oct;22(4-5):299-304.
27. Ghai B, Bansal D, Kay JP, Vadaje KS, Wig J. Transforaminal versus parasagittal interlaminar epidural steroid injection in low back pain with radicular pain: a randomized, double-blind, active-control trial. Pain Physician 2014 Jul-Aug; 17 (4): 277-90.
28. Riew KD, Yin Y, Gilula L, Bridwell KH, Lenke LG, Lauryssen C, Goette K. The effect of nerve root injections on the need for operative treatment of lumbar radicular pain. A prospective, randomized, controlled, double-blind study. *J Bone Joint Surg Am* 2000 Nov;82-A(11):1589-93.
29. Riew KD, Park JB, Cho YS, et al. Nerve root blocks in the treatment of lumbar radicular pain. A minimum five-year followup. J Bone Joint Surg Am. 2006 Aug;88(8):1722-5.
30. Manson NA, McKeon MD, Abraham EP. Transforaminal epidural steroid injections prevent the need for surgery in patients with sciatica secondary to lumbar disc herniation: a retrospective case series. Can J Surg 2013; 56 (2): 89-96.
31. Kennedy DJ, Plastaras C, Casey E, Visco CJ, Rittenberg JD, Conrad B, Sigler J, Dreyfuss P. Comparative effectiveness of lumbar transforaminal epidural steroid injections with particulate versus nonparticulate corticosteroids for lumbar radicular pain due to intervertebral disc herniation: a prospective, randomized, double-blind trial. Pain Med 2014; 15 (4): 548-55.

32. Kaufmann TJ, Geske JR, Murthy NS, Thielen KR, Morris JM, Wald JT, Diehn FE, Amrami KK, Carter RE, Shelerud RA, Gay RE, Maus TP. Clinical effectiveness of single lumbar transforaminal epidural steroid injections. Pain Med 2013; 14 (8): 1126-33.
33. Murthy NS, Geske JR, Shelerud RA, Wald JT, Diehn FE, Thielen KR, Kaufmann TJ, Morris JM, Lehman VT, Amrami KK, Carter RE, Maus TP. The effectiveness of repeat lumbar transforaminal epidural steroid injections. Pain Med 2014; 15 (10): 1686-94.
34. MacVicar J, King W, Landers MH, Bogduk N. The effectiveness of lumbar transforaminal injection of steroids: a comprehensive review with systematic analysis of the published data. Pain Med 2013; 14 (1): 14-28.
35. Deyo RA, Dworkin SF, Amtmann D, Andersson G, Borenstein D, Carragee E, Carrino J, Chou R, Cook K, DeLitto A, Goertz C, Khalsa P, Loeser J, Mackey S, Panagis J, Rainville J, Tosteson T, Turk D, Korff MV, Weiner DK. Report of the NIH Task Force on research standards for chronic low back pain. Pain Med 2014; 15 (8): 1249-67.