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Cost-Effectiveness of Epidural Steroid Injections to Treat Lumbosacral Radiculopathy in Chronic Pain Patients Managed Under Workers' Compensation

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Cost-Effectiveness of Epidural Steroid Injections to Treat Lumbosacral Radiculopathy in Chronic Pain Patients Managed Under Workers' Compensation

by

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Dedication

To everything that touched my life

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Abstract

No conclusive evidence exists to determine that epidural steroid injections (ESIs) provide lasting improvements in chronic pain due to herniated discs, in the Workers' Compensation population. Recently, an article by Armon et.al was published by the American Academy of Neurology, which stated that the routine use of ESIs is not recommended and that further studies are needed to elucidate this controversy (Armon, Argoff, Samuels, & Backonja, 2007).

In 1998, back pain in the United States was estimated to have incurred total health-care expenditures of $90.7 billion. Medicare part B. claims in 1999 for 40.4 million individuals amounted to $49.9 million for lumbar epidural steroid injections alone. The practice of evidence based medicine will reduce health care costs and discomforts of the procedure.

The objective of this study was to determine if ESIs will result in reduction of pain levels and pain medications used, and to determine the cost of treatment.

In this retrospective cohort chart review study, where claimants served as their own controls, pain levels and medications used, were retrospectively assessed using documented pain scores based on the numerical pain scale, and medications prescribed, respectively. Further correlations were made with clinical and MRI findings. Costs were

derived based on the amount billed by the provider to the insurance company. A randomized list of 600 charts from the insurance company's database was obtained and 120 were selected for study based on criteria. Data abstracted included gender, weight, date of injury, clinical symptoms, MRI findings, pain scores before and after ESIs, medications used before and after ESIs , date of ESIs, total amount billed for the ESIs, surgery, and total cost of the injury to date of data abstraction.

The mean pain score before was 6.97 and 7.51 after ESIs The mean number of pain medication groups before was 2.41 and 3.10 after ESIs. The mean morphine equivalent dose before was 10.50mg and 22.07mg after ESIs. There was no significant correlation between amount billed for ESI and pain level.

It was concluded that use of ESIs in the treatment chronic radicular pain does not reduce workers' pain levels, amount of pain medications, or narcotic consumed. These measures of discomfort remained the same, or were increased regardless of money spent.

Chapter I

Introduction

Lower back pain is the most costly disease in the United States and its incidence is increasing. Lifetime prevalence of lower back pain in the general population is approximately 80%, and is responsible for $14 billion a year expenditure in the United States alone (Rosenberg, Grabinsky, Kooser, & Boswell, 2002). Lower back pain typically responds to conservative treatment or resolves spontaneously within six weeks (Buttermann, 2004a). Most people recover with conservative care and as many as 90% of patients improve naturally, after 1 year (Cyteval et al., 2006).

There are various treatment modalities, which include medications such as non-steroid anti-inflammatories (NSAIDS), narcotics, anti-seizure, antidepressants, and muscle relaxants. Other treatments are physical therapy, transcutaneous electrical nerve stimulation, acupuncture, chiropractic manipulations, lifestyle modifications, back school, and ESIs (Cooper, Lutz, Boachie-Adjei, & Lin, 2004).

Epidural steroid injections (ESIs) have been used in the treatment of radicuar pain since 1952 (Delport, Cucuzzella, Marley, Pruitt, & Fisher, 2004). Its effectiveness has not been challenged until recently most notably by an article published by the American Academy of Neurology which stated that ESI is not recommended for the long-term treatment of lumbosacral radiculopathy (Armon et al., 2007). It was

recommended that more research be conducted in this area. This study sought to better clarify inconsistencies associated with the use of ESIs. Our null hypothesis was that treatment of chronic lumbosacral radicular pain with ESIs will not change pain levels, medications used, and total narcotic dose used, in claimants managed under workers' compensation, and that cost will not be significant.

Questions we sought to answer were as follows:

1. Will the pain level decrease 3 to 12 months after the first ESI administration?
2. Will the number of groups of pain medications used to control pain, be reduced 3 to 12 months after administration of the first ESI.
3. Will the narcotic dose used be reduced 3 to 12 months after administration of the first ESI?
4. What was the mean cost per ESI treatment?

ESIs may be administered by different methods such as translaminar, caudal, or transforminal. In this study, the fluoroscopically guided transforminal approach of ESIs to treat chronic lumbosacral radicular pain due to herniated nucleus pulposus was addressed. Transforminal (periradicular) infiltration permits precise application of steroids in the vicinity of the irritated nerve root, resulting in massive concentration of steroid at the dorsal root ganglion, which is presumably responsible for the pain (Rosenberg et al., 2002), and which provides the best chance for a therapeutic effect. Immediate pain relief could be expected if both clinical diagnosis and needle placement are accurate (Zhou, Furgang, & Zhang, 2006).

Compression and inflammation are the two mechanisms by which pain is produced. Function of the thickly myelinated Aβ fiber is more likely to be affected by

compression than the thinly myelinated Aδ fiber, or unmyelinated C-fibers (Schiff & Eisenberg, 2003). Aδ and C-fibers are affected more by the root inflammation caused by leakage of inflammatory substances from the nucleus pulposus (Schiff & Eisenberg, 2003).

Medications used for ESIs

Typically, a solution containing cortisone (steroid) with local anesthetic (lidocaine or bupivacaine), and/or saline is used. A steroid is usually injected as an anti-inflammatory agent. Inflammation is a common component of many lower back conditions, and reducing inflammation helps reduce pain. Triamcinolone acetonide, dexamethasone, and methylprednisolone acetate are commonly used steroids.

Lidocaine is a fast acting local anesthetic used for temporary pain relief. Bupivacaine, a longer lasting anesthetic agent may also be used. Although primarily used for pain relief, these local anesthetics also act as flushing agents to dilute the chemical or immunologic agents that promote inflammation. Saline is used for the same purpose.

Steroid Actions

Steroids inhibit the inflammatory response caused by chemical and mechanical sources of pain. They inhibit the formation of nerve root edema (Rydevik, Brown, & Lundborg, 1984), have an anti-inflammatory effect (Kantrowitz, Robinson, McGuire, & Levine, 1975), increase blood flow to neural elements thus improving ischemic neuritis (Fukusaki, Kobayashi, Hara, & Sumikawa, 1998), or block conduction in nociceptive nerve fibers (Johansson, Hao, & Sjolund, 1990).

Steroids also work by reducing the effect of the immune system to react to inflammation associated with nerve damage. A typical immune response is generation of white blood cells and chemicals to protect the body against infection and foreign substances such as bacteria and viruses. Inhibiting the immune response with an epidural steroid injection can reduce pain associated with inflammation.

ESIs are often used to treat radicular pain that radiates from the site of a pinched nerve in the lower back to the area of the body aligned with that nerve such as the back of the leg, or into the foot. Inflammatory chemicals such as substance P, phospholipase A2, arachidonic acid, tumor necrosis factor, Interleukin-1, and prostaglandin E2, and immunologic mediators can generate pain and are associated back problems such as disc herniation. This condition, as well as many others, provoke inflammation that cause significant nerve-root irritation and swelling. Studying the effects of ESIs on patients with lumbosacral radiculopathy is useful in helping to establish general guidelines for patient care (Cooper et al., 2004).

ESIs are often used to treat radicular pain defined as pain that radiates from the site of a pinched nerve in the low back to the area of the body aligned with that nerve, such as the back of the leg or into the foot. Inflammatory chemicals (e.g. substance P, PLA2, arachidonic acid, TNF-α, IL-1, and prostaglandin E2) and immunologic mediators can generate pain and are associated with common back problems such as lumbar disc herniation. These conditions, as well as many others, provoke inflammation that in turn can cause significant nerve root irritation and swelling.

Steroids bind albumin and some have high affinity for the protein, transcortin. Steroid potency and duration of effect vary. Dexamethasone is very potent and has a

duration of action of 36 to 54 hours. Triamcinolone is less potent with a duration of action of 12 to 36 hours and prednisolone is least potent, with a duration of action of 16 to 36 hours.

Steroids also stimulate Lipocortin-1 which escapes to the extracellular space, where it binds to the leukocyte membrane receptors and inhibit various inflammatory events such as epithelial adhesion, emigration, chemotaxis, phagocytosis, respiratory burst, and the release of various inflammatory mediators such as lysosomal enzymes, cytokines, tissue plasminogen activator, chemokines from neutrophils, macrophages, and mastocytes.

Steroid Receptors

Steroid receptors are intracellular receptors that share a common structure of 4 domains that are functionally homologous and which perform signal transduction. These receptors are part of the nuclear receptor family. Depending on the steroid they bind, receptors are located either in the cytosol and move to the cell nucleus upon activation, or spend their life in the nucleus waiting for the steroid to enter and activate them.

Uptake in the nucleus has to do with Nuclear Localization Signals found in a region of the receptor. This signal is usually covered by heat shock proteins which bind the receptor until the steroid is present. When the steroid binds, the receptor undergoes a conformational change, the heat shock proteins come off and the receptor, together with the bound steroid, enter the nucleus to act upon transcription.

In the nucleus, receptor complexes act as transcription factors, augmenting or suppressing transcription of particular genes by their action on DNA. Messenger RNA

produced, exit the nucleus and interact with ribosomes. After translation of the genetic message specific proteins are produced. The specific proteins perform a biological task.

Epidural Steroid Injection

Epidural Steroid Injection (ESI): An epidural steroid injection is an administration of medications through a needle into the epidural space. The medications frequently used are a combination of a local anesthetic, (numbing medicine), such as lidocaine, and a steroid such as triamcinolone, dexamethasone, and methylprednisolone, which are strong anti-inflammatory medications.

Steroids produce a therapeutic effect by lessening the compression caused by herniated discs, and by reducing neural edema. It also reduces the amount of inflammation around the nerve root.

ESIs deliver steroids directly into the epidural space in the spine. Sometimes additional fluid (local anesthetic and/or a normal saline solution) is used to help 'flush out' inflammatory mediators from around the area that may be a source of pain The epidural space encircles the dural sac and is filled with fat and small blood vessels. The dural sac surrounds the spinal cord, nerve roots, and cerebrospinal fluid.

Lumbosacral Radiculopathy

ESIs deliver steroid medication directly into the epidural space in the spine. The epidural space encircles the dural sac and is filled with fat, and small blood vessels. The dural sac surrounds the spinal cord, nerve roots, and cerebrospinal fluid.

The anatomy of the lumbar epidural space is the key to understanding the mechanism of radiculopathic pain. The sinuvertebral nerves innervate structures in the lumbar epidural space. These nerves originate distal to the dorsal root ganglion, then run

back through the intervertebral foramen to supply the arteries, venous plexi, and lymphatics.

At the inner aspect of the intervertebral foramen, the sinuvertebral nerves divide into ascending and descending branches that freely communicate with corresponding branches from the segment above, from the segment below, and from the opposite side.

The sinuvertebral nerve supplies the posterior longitudinal ligament, superficial annulus fibrosus, epidural blood vessels, anterior dura mater, dural sleeve, and posterior vertebral periosteum. The 2 structures capable of transmitting neuronal impulses that result in the experience of pain, are the sinuvertebral nerve and the nerve root. The posterior rami of the spinal nerves supply the apophyseal joints above and below the nerve and the paraspinous muscles at multiple levels.

Herniated Nucleus Pulposus

From a biomechanical standpoint, the lumbar intervertebral discs are highly susceptible to herniation because they are exposed to tremendous forces, principally by magnification of forces that result from the lever effect of the human arm in lifting, the forces generated by the upper trunk mechanics with rotation, flexion/extension, and side-bending on the discs below, and by vertical forces associated with the upright position.

Each intervertebral disc is a fluid system and hydraulic pressure is generated whenever a load is placed on the axial skeleton. The hydraulic pressure mechanisms then multiply the force on the annulus fibrosus of the intervertebral disc to make it 3-5 times that which is exerted on the axial skeleton.

Herniation of the intervertebral disc can cause impingement of the above neuronal structures, thus causing pain. The presence of disc material in the epidural space is

thought to initially result in direct toxic injury to the nerve root by chemical mediation and then exacerbation of the ensuing intraneural and extraneural swelling, which results in venous congestion and conduction block. Notably, the size of the disc herniation has not been found to be related to the severity of the patient's pain.

The nucleus pulposus, a gelatinous substance, is the remnants of the embryonic notochord. Intervetebral disc herniations act as foreign bodies in the epidural space (Reyentovich & Abdu, 2002). The body launchs an inflammatory response once this material leaves its usual sequestered position inside the annulus fibrosus and extends outside during a herniation. The extruded disc material leads to mechanical compression and chemical radiculitis (Cyteval et al., 2006) of the affected nerve root.

Several immunohistological studies have demonstrated that the immune system attempts to remove the invading disc tissue (Doita, Kanatani, Harada, & Mizuno, 1996), (Ito et al., 1996), (Hirabayashi, Kumano, Tsuiki, Eguchi, & Ikeda, 1990). One study concluded that vessels from the epidural fat infiltrate the disc material. Accompanying the vessels are granulation tissue with eventual transformation into scar tissue (Hirabayashi et al., 1990). Macrophages probably play a vital role in both resorption and cytokine (bFGF) signaling to promote endothelial cell proliferation and neovascularization (Doita et al., 1996). Macrophage induction of a chondrocyte enzyme (matrix metalloproteinase-3) plays a key role in disc resorption through several mechanisms.

Pain is also believed to be mediated by inflammatory mechanisms involving substances such as phospholipase A2, nitric oxide, and prostaglandin E. These mediators are found in the nucleus pulposus itself. Phospholipase A2 has been found in high

concentrations in herniated lumbar discs. This substance acts on cell membranes to release arachidonic acid, a precursor to other prostaglandins and leukotrienes that further advance the inflammatory cascade. Additionally, leukotriene B4 and the substance thromboxane B2, have been found to have direct nociceptive stimulatory roles.

Magnetic Resonance Imaging (MRI)

MRI has excellent sensitivity in the diagnosis of lumbar disc herniation and is the imaging study of choice for nerve root impingement. Its preference is tempered by the prevalence of abnormal finding in asymptomic subjects. MRIs are not necessary in all patients who have clinical findings consistent with radiculopathy and should be reserved for cases in which imaging results are likely to guide treatment. When physical examination and electrodiagnostic findings do not indicate exact levels of pathology, an MRI may help (Price, Arden, Coglan, & Rogers, 2005).

Workers' Compensation Insurance

The industrial expansion which took place in the United States during the 19th century was accompanied by significant increase in workplace accidents. During that era injured workers had to sue their employers for negligence, to obtain compensation. In the early 1900s a state by state pattern of legislative proposals designed to protect injured workers, began to emerge.

The concept that workers should be protected from, and compensated for injury or illness occurring in the workplace, came about with the rise of the trade union movement at the beginning of the 20th Century. Workers Compensation Insurance is a direct result of public awareness and outrage at the poor and often dangerous working conditions people were forced to labor under.

Under workers' compensation, injured workers are entitled to specific benefits such as medical care, lost wages, temporary disability benefits, permanent disability benefits, vocational rehabilitation services, supplemental job displacement benefits, and death benefits including death from terrorist attacks.

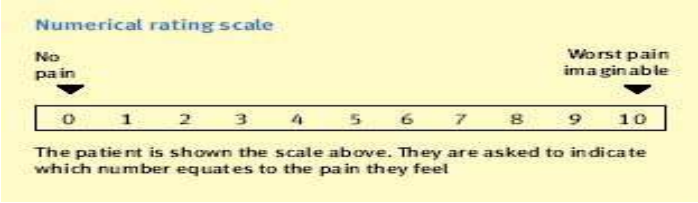
Cost-Effectiveness Analysis

This is the evaluation of health outcomes and resource costs of health interventions.

Numerical Pain Scale

This is a system of subjectively rating pain based on a scale of 0 to 10 with 0 being no pain and 10 being the worst pain imaginable.

The claimant is shown a numerical pain scale chart and asked to rate the pain.



Chapter II

Review of the Literature

Epidural Steroid Injection Definition:

An epidural steroid injection is an administration of medications through a needle into the epidural space. The medications frequently used are a combination of a local anesthetic, or numbing medicine, such as lidocaine and a steroid, which is a strong anti-inflammatory medicine.

History

It appears that the anatomic subarachnoid space was first discovered by Egyptians practicing mummification in 3,500 B.C. In the 1920s the epidural space was rediscovered by the medical profession. Initially, air and then an iodinated poppy seed oil developed by Sicard and Forestier in France, was used to outline this space.

Economic Analysis

Economic analysis is a necessary input before a choice is made between two or more competing treatments for the same illness. This analysis can be achieved with cost-effective analysis, which is a ratio in which health changes resulting from an intervention are captured in the denominator and changes in resource use, valued in monetary terms, appear in the numerator, both being compared with a specific alternative (Karppinen et al., 2001).

Gender Differences

A significant number of men and women experience treatment for low back pain with lumbar ESIs. In one study, men reported greater injection pain than women. Predictors of acute ESI pain and treatment outcome differ across sexes. Several variables predict injection pain among women. These include outcome expectancies, baseline clinical pain, pain-related anxiety, depression, and emotion-focused and problem-focused avoidance (Inman, Faut-Callahan, Swanson, & Fillingim, 2004).

Among men, problem-focused avoidance and pain duration, were associated with injection pain. Regarding treatment outcomes, coping strategies were sex-dependently associated with reductions in pain, disability, and depression. Interventional pain treatments should consider that potentially important determinants of treatment outcomes might differ in women and men (Inman et al., 2004).

Safety of Epidural Steroid Injections

Although serious complications are rare, they must be considered. Risks include inadvertent needle trauma to related structures such as nerves and blood vessels resulting in hematomas, nerve damage and the potential for paraplegia. Severe infections are rare, occurring in 0.01% to 0.1% of injections. Diabetics receiving ESIs are predisposed to infection. Post-dural puncture headaches present a more frequent complication (0.4%). There may be temporary numbness of bowels and bladder.

Drugs chosen for epidural steroid injections have been subject to debate due to the possibility of the preservative having neurotoxic effects. Steroid medications are suspended in polyethylene glycol, and benzyl alcohol preservative can be added. Two preparations of corticosteroid suspensions used most extensively for ESIs are triamcinolone diacetate and methylprednisolone acetate.

Soluble preparations are not used because they are rapidly cleared from the spinal canal and have produced seizures and segmental hyperalgesia when injected intrathecally in animals (Abram, 1999). Inadvertent intrathecal injections have been considered to potentially cause arachnoiditis. Other complications include epidural abscess, meningitis, hypercorticism, and allergy (Price et al., 2005).

In addition to risks from the injection, there are also potential side effects from the steroid medication itself. These tend to be rare and much less prevalent than the side effects from oral steroids. Reported side effects from ESIs include localized increase in pain, non-positional headaches resolving within 24 hours, facial flushing, anxiety, sleeplessness, fever the night of injection, high blood sugar, a transient decrease in immunity because of the suppressive effect of the steroid, stomach ulcers, avascular necrosis of the hips and cataracts.

Other factors include underlying medical conditions, medications, type of interventional pain management procedures, the particular drugs injected, physician skill level, and patient preparedness (Zhou et al., 2006).

Off-Label use of Steroids

Kenalog (triamcinolone suspension) is a steroid used in epidural injections. This drug is "not recommended for administration via the epidural route" according to the material data sheet provided by its manufacturers, Bristol Myers Squibb (Wallingford, Connecticut, U.S.A.). As with any "off-label" use of a drug or device, their application is dependent upon the individual doctor's discretion and clinical judgment. It is the individual physician who then takes personal responsibility for this (Charles V. Burton, 2008).

Success Rates of ESIs

The reported success rates of ESIs have varied greatly, ranging from 18% to 90% (Koes, Scholten, Mens, & Bouter, 1995), (Rozenberg et al., 1999). The number of published randomized controlled trials is small, with most containing serious methodological flaws (Rozenberg et al., 1999). One of the best designed studies by Carrette et. al. showed no improvement in outcomes after ESI at a 3-month follow-up (Carette et al., 1997). This study has been criticized for not using fluoroscopy during the ESIs (Cluff et al., 2002).

Pain

The International Association for the Study of Pain Subcommittee on Taxonomy, defines pain as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage" and "is always unpleasant and therefore also an emotional experience".

Research is consistent with the hypothesis that multiple components contribute to the pain experience. These include a physiological component, sensory, affective, and cognitive components (Waddell, O'Connor, Boorman, & Torsney, 2007), a behavioral component, and the sociocultural component. It has suggested that measurement of pain be distinguished from assessment of pain. The problem with the National Pain Treatment Algorithm (NPTA) is that the psychological and emotional components of pain are not measured by a one-dimensional rating, and they are poorly treated by opioids (Vila et al., 2005). Although the pathomechanism of pain has not yet been fully elucidated, phospholipase A2 and nitric oxide are thought to play vital roles (Minamide et al., 1999), (Saal et al., 1990).

Pain Related Disability, Race, and Gender Issues

Patients receiving disability compensation for musculoskeletal problems are frequently evaluated by physicians and present a particular challenge, especially if surgical or other invasive procedures are being considered. There is evidence that outcomes among such patients are generally worse than for individuals with similar clinical conditions who are not receiving disability compensation (Harris, Mulford, Solomon, van Gelder, & Young, 2005).

Dissatisfaction with the workers' compensation system as it relates to management of lower back pain, has been voiced from many perspectives. This compensation system, is designed to provide equal access to standard medical treatment and disability reimbursement, regardless of race or socioeconomic status, so that issues of access to medical care and quality of care, which are confounded by race and socioeconomic status (e.g., private insurance status) are presumably minimized.

A study by Chibnall et. al. looked at associations between satisfaction and disability. They found that race had a direct association with disability, but was also mediated through other variables. African Americans received less treatment/compensation across the workers' compensation variables (relative to Caucasians), which predicted lower satisfaction. This pattern held true for lower socioeconomic status claimants and those with regional backache. This predicted higher levels of post-settlement disability (Chibnall & Tait, 2005).

There are data to suggest that African Americans may cope less effectively with pain (Green, Baker, Smith, & Sato, 2003), (Green, Baker, Sato, Washington, & Smith,

2003) and may focus on the pain, thus experiencing higher levels of emotional distress (Jordan, Lumley, & Leisen, 1998).

MRI in Degenerative Disc Disease

The place of MRI in degenerative disc disease has not been fully established. MRI demonstrated lesions correspond well with operative findings, however, the majority of disc bulges and protrusions are asymptomatic. Although MRI findings correlate well with clinical findings for site and level of disc herniation, they correlate poorly with severity of symptoms. It is thought that this is due to the fact that pain is caused more by inflammation than compression (Price et al., 2005).

Natural History of Herniated Nucleus Pulposus (HNP)

Lower back pain typically responds to conservative treatment, or resolves spontaneously within 6 weeks (Buttermann, 2004a). The presence of a tear in the posterior longitudinal ligament (PLL) is associated with greater regression of the herniated fragment and has been noted with larger disc herniations. Exposure of herniated disc materials to the epidural vascular supply through the ruptured PLL has been suspected to play a part in the mechanism of disappearance of the herniated nucleus pulposus (Ahn, Ahn, & Byun, 2000).

Genetic factors may also play a role in the etiology of intervertebral disc herniation. Researchers using genetic techniques, have identified several putative disease causing variations in collagen IX (Arg 103 to Trp) which when present, may increase the risk of lumbar disc disease threefold (Annunen et al., 1999), (Paassilta et al., 2001).

Surgical Considerations in Lumbosacral Radiculopathy

Radiculopathy caused by lumbar herniated discs is the most common cause of radicular leg pain in the adult working population (Frymoyer, 1988). Although most patients improve over several weeks, surgical treatment is frequently considered for patients with symptoms that are persistent or severe (Andersson et al., 1996). More than 250,000 elective lumbar spine operations are performed each year, in the United States, with discectomy being the most common procedure (Taylor, Deyo, Cherkin, & Kreuter, 1994).

The long-term benefit of surgical versus non-surgical treatment for patients with radiculopathy caused by herniated discs has been assessed by Weber et. al.. In this trial, surgery was superior to conservative treatment at the 1yr follow-up and non-significantly better at 4 years. At 10 years, the outcomes of the two treatments were similar (Weber, 1983).

Accident Neurosis in the Working Population

Accident neurosis is a term coined by Henry Miller, MD in his series of lectures delivered in 1961 as part of the Milroy Lectures delivered before the Royal College of Physicians of London. He based accident neurosis on his personal experience after practicing more than 40 yrs as a neurologist.

The syndrome is seen to present a unique combination of clinical features, amongst the most remarkable of which are an inverse relation to the severity of the provoking injury; an unexpectedly inconstant correlation with neurotic predisposition; scanty objective signs of emotional disturbance; a differential social incidence; and an absolute failure to respond to therapy until the compensation issue was settled, after

which nearly all the cases described, recovered completely without treatment (Miller, 1961), (Miller, 1962).

Burton Report on ESIs

Epidural steroid administration is an empiric therapeutic modality commonly used to treat lumbosacral radiculopathy due to herniated disc. If the steroid is inadvertently injected into the subarachnoid space rather than the epidural space, serious disability and incapacitation can occur. Synthetic steroids containing neurotoxic agents like ethylene glycol when introduced into the subarachnoid space can cause a potentially disabling condition referred to as adhesive arachnoiditis (Charles V. Burton, 2008).

Steroids such as these are not approved by the manufacturers for epidural injection and are clearly known to be toxic if misinjected. It is interesting to note that they still appear to be used by the majority of physicians now performing ESIs (Charles V. Burton, 2008).

ESIs have become a widespread non-specific treatment for lower back pain in the United States and in other countries. Its popularity seems to relate to a "knee-jerk" means of providing short-term back pain relief. The rationale for ESI use, is its general anti-inflammatory action, and the observation that many patients with back pain can recover spontaneously if their initial pain is moderated. Statistics demonstrate that the same result can be achieved with most forms of other non-invasive therapies such as physical therapy (Charles V. Burton, 2008).

A remarkable amount of ignorance exists today regarding ESIs. Many physicians performing ESIs on a regular basis do not even understand the relationship of this procedure to the possibility of creating adhesive arachnoiditis months later. It may be

sensible to require medical professionals to fully explain the procedure and other options before it is carried out. ESIs have been just another example of the New Guinea Syndrome which hopefully will pass from the scene in the future (Charles V. Burton, 2008).

Chapter III

Methods

The hypothesis was that treatment of chronic lumbosacral radicular pain with epidural steroid injections will not change pain relief, medications used, and total narcotic dose used, in claimants managed under workers' compensation.

Selection and Evaluation of Study Population

The study sample was 120 claimants' charts which met inclusion and exclusion criteria. They were selected from a random list of 611 charts pulled from the database of a large workers compensation insurance company for the 4 year period from July 1st 2004 to June 30th 2007.

The list of charts was generated by searching the database for the Current Procedural Terminology (CPT) code 64483, where the date of injury and date of procedure matched research criteria. Business Objects, a query software tool was used to generate the list. The randomized process utilized a Statistical Analysis Software (SAS) program (version 9.1.3).

Selection Criteria

Inclusion Criteria:

1. Patients who have received their first treatment with an ESI from July 1, 2004 to June 30 at 2007.

2. Patients who were suffering from lumbosacral radiculopathy for three months prior to the first ESI thus meeting the definition for chronic pain
3. Patients whose documented signs and symptoms met criteria for a diagnosis of Chronic Lumbosacral Radiculopathy, which included the following:-
    a) Pain lasting greater than three months.
    b) Lower back pain radiating down past the knee joint on one or both lower extremities.
    c) Positive straight leg raise test on one or both lower extremities.
    d) Symptoms of numbness, weakness, and tingling sensation on one or both lower extremities.
4. MRI findings of one or more levels of herniated lumbar disc.
5. Patients within the ages of 30 to 50 years, inclusive.

Exclusion Criteria:

1. Patients who have had prior treatments with ESIs.
2. Patients with multiple pain syndromes which precludes a clearly defined source of pain.
3. Patients with multiple injures and congenital malformations.
4. Patients with multiple co-morbidities including diabetes, arthritis, etc..
5. Patients treated with epidural spinal injections before three months post-injury.
6. Patients with prior lower back surgery.

After reviewing 463 charts from the randomized list of 611 charts, the sample size of 120 claimants charts was attained and chart review from the list was terminated (Figure 1).

Data Abstraction

Study variables abstracted from sample charts included age at the time of the ESI, gender, weight, date of injury, clinical criteria for the diagnosis of chronic lumbosacral radiculopathy, MRI findings, pain scores not more than two months before the ESI and 3 to 12 months after ESI, date of ESI, the number of groups of medications before and after ESI within the above time frame.

The six groups of medication studied were narcotics, nonsteroidal anti-inflammatory drugs (NSAIDS), tramadol, antiseizure medications, antidepressants, and muscle relaxants. The narcotic dose was standardized to a morphine equivalent dose using an opioid analgesia comparison chart based on morphine 10 mg administered parenterally.

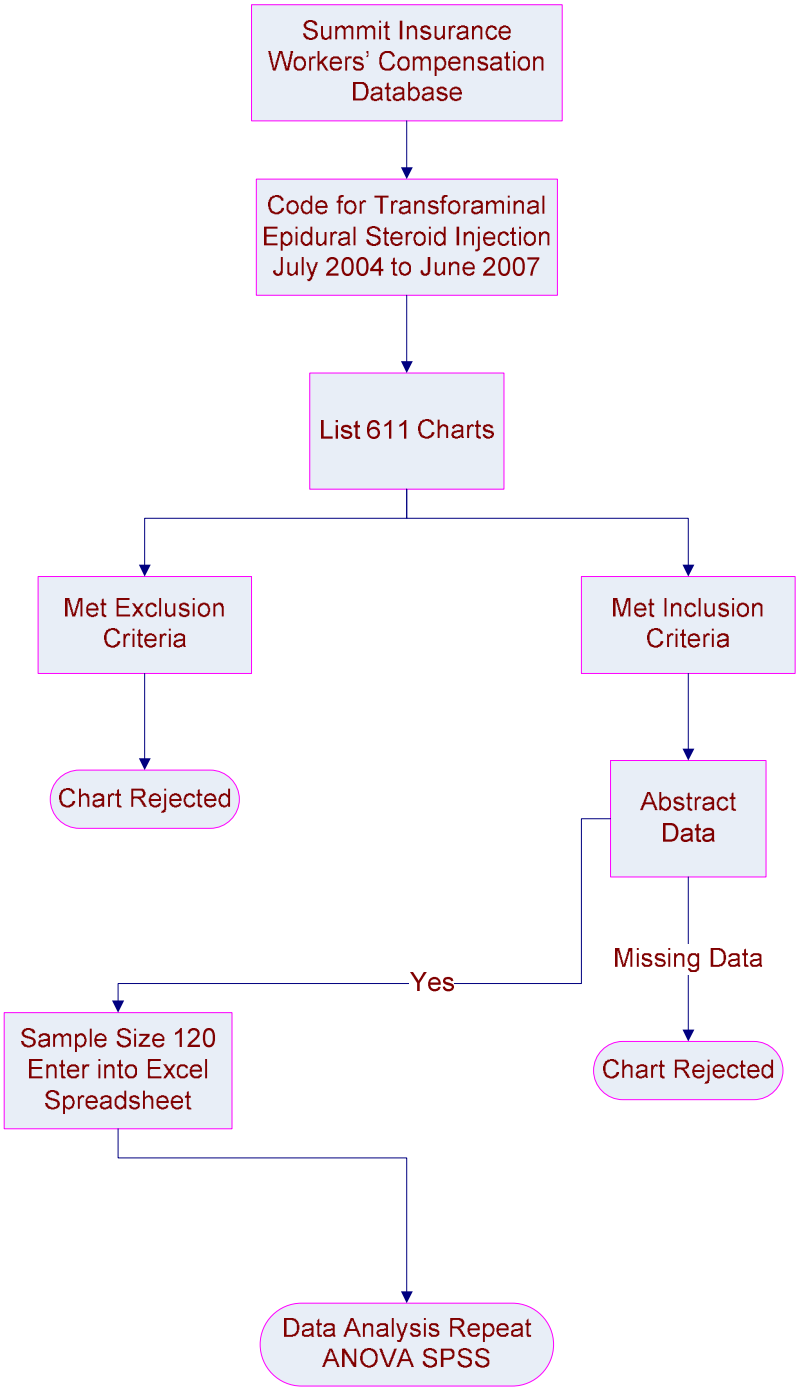
Cost Data

Cost data abstracted from claimants' charts as billed for the epidural procedure, were used to calculate the mean cost of the ESI treatment per patient, using Excel software.

Data Processing and Analysis

Data was entered into Excel Spreadsheets and analyzed using Statistical Package for the Social Sciences (SPSS) a computer program for statistical analysis. Repeat ANOVA analysis was used.

Figure 1:
Flow Diagram of Data Acquisition



Chapter IV

Results

Data was analyzed using SPSS and Excel computer software.

The study population consisted of 120 claimants' charts with a diagnosis of lumbosacral radiculopathy due to one or more herniated nucleus pulposus. 24 claimants (20%) were females, and 96 claimants (80%) were males. Ages ranged from 30 to 50 years, with a mean age of 43years. The weight range for the sample population was 14 9.09kg to 136.36kg (108 to 300 pounds). The mean weight for females was 75.45 kg (166 pounds), and the mean weight for males was 87.73 kg (193 pounds). All claimants met criteria.

Average time of injury to ESI was 6.83 months. Average time prior to ESI when pain level, and medication use data was taken, was 1 month. Average time after ESI when pain level and medication use data was taken, was 6.36 months. 34 claimants (28.33%), underwent surgery for lower back pain within one year post-ESI treatment.

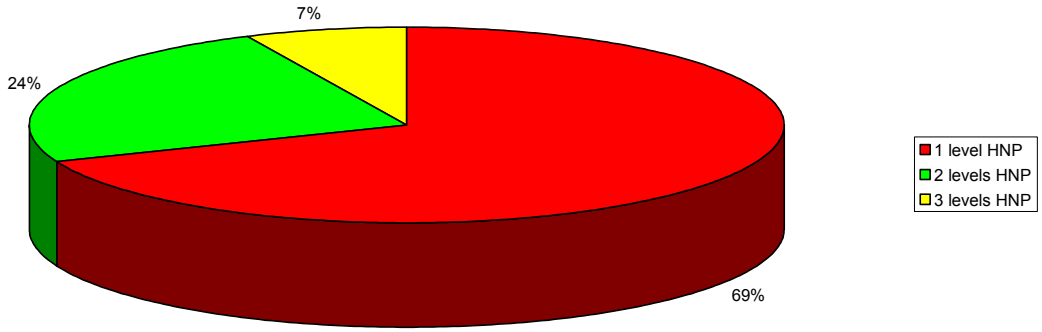
The mean cost per ESI treatment per claimant was $1,850.00 and the total billed for the sample population was $222,043.00

Table 1: Demographic and General Data

Variable	Number Claimants	Percent Claimants	Mean
Age groups in years 30 - 34 35 - 39 40 - 44 45 - 49 50 - 50	 21 26 32 26 11	 17.50% 21.67% 26.67% 21.67% 9.17%	
Female	24	20%	
Male	96	80%	
Weight Female			75.45Kg (166 lbs)
Weight Male			87.73Kg (193 lbs)
Weight Range Female and Male			49.09 - 136.36 Kg 108 - 300 lbs
Time Injury to ESI			6.83 months
Time Pre – ESI to Pain Level			1 month
Time Post – ESI to Pain Level			6.36 months
Surgery	34	28.33%	
$ Billed per ESI Treatment			$1,850.00
$ Total Billed for Sample Size of 120			$222,043.00

MRI findings for the sample population showed 83 claimants (69%) with one herniated nucleus pulposus. 29 claimants (24%) had two levels of herniated nucleus pulposus and 8 claimants (7%) had three or more levels of herniated nucleus pulposus.

Figure 2: Distribution of levels on Herniated Nucleus Pulposus (HNP)



The mean pain score prior to ESI was 6.97 and the mean pain score after ESI was 7.51 based on a numerical pain scale. Pain medications were selected from an average of 2.41 groups to manage pain prior to ESI, and from an average of 3.10 groups to manage pain after ESI. The mean morphine equivalent dose prior to ESI was 10.50 mg and 22.70 mg after ESI.

Table 2: Differences in Patient Pain Level and Medication Pre- and Post-ESI

Variables	Mean	Std. Error	F	df	N2
Pain level			12.76***	1,119	0.10
Pre-ESI	6.97	0.17			
Post-ESI	7.51	0.15			
Medication Groups			81.73***	1,119	0.92
Pre-ESI	2.41	0.08			
Post-ESI	3.10	0.08			
Morphine Equiv. Dose			33.64***	1,119	0.22
Pre-ESI	10.50	1.35			
Post-ESI	22.07	2.32			

Note: $N = 120$; *$p < .05$ **$p < .01$ ***$p < .001$

Figure 3: Mean Pain Levels Pre-ESI and Post-ESI

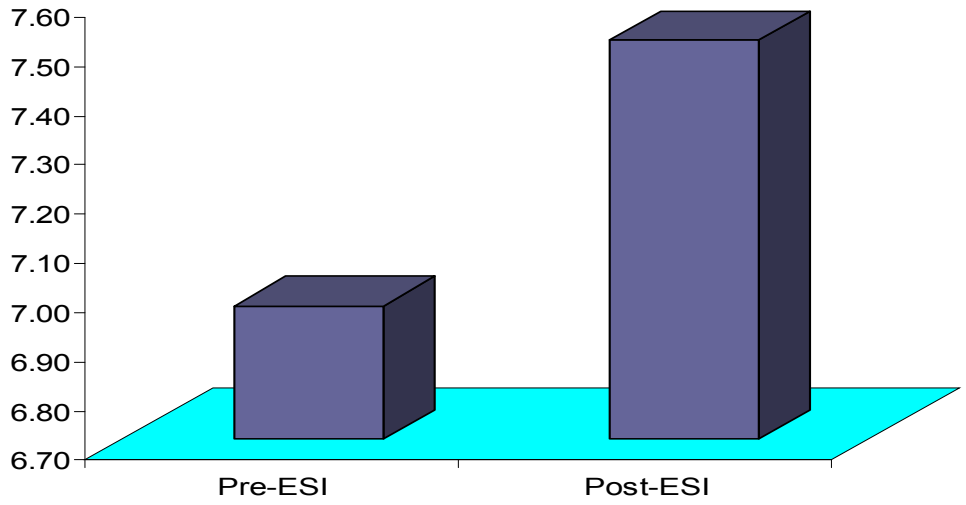


Figure 4: Morphine Equivalent Dose Pre-ESI and Post-ESI

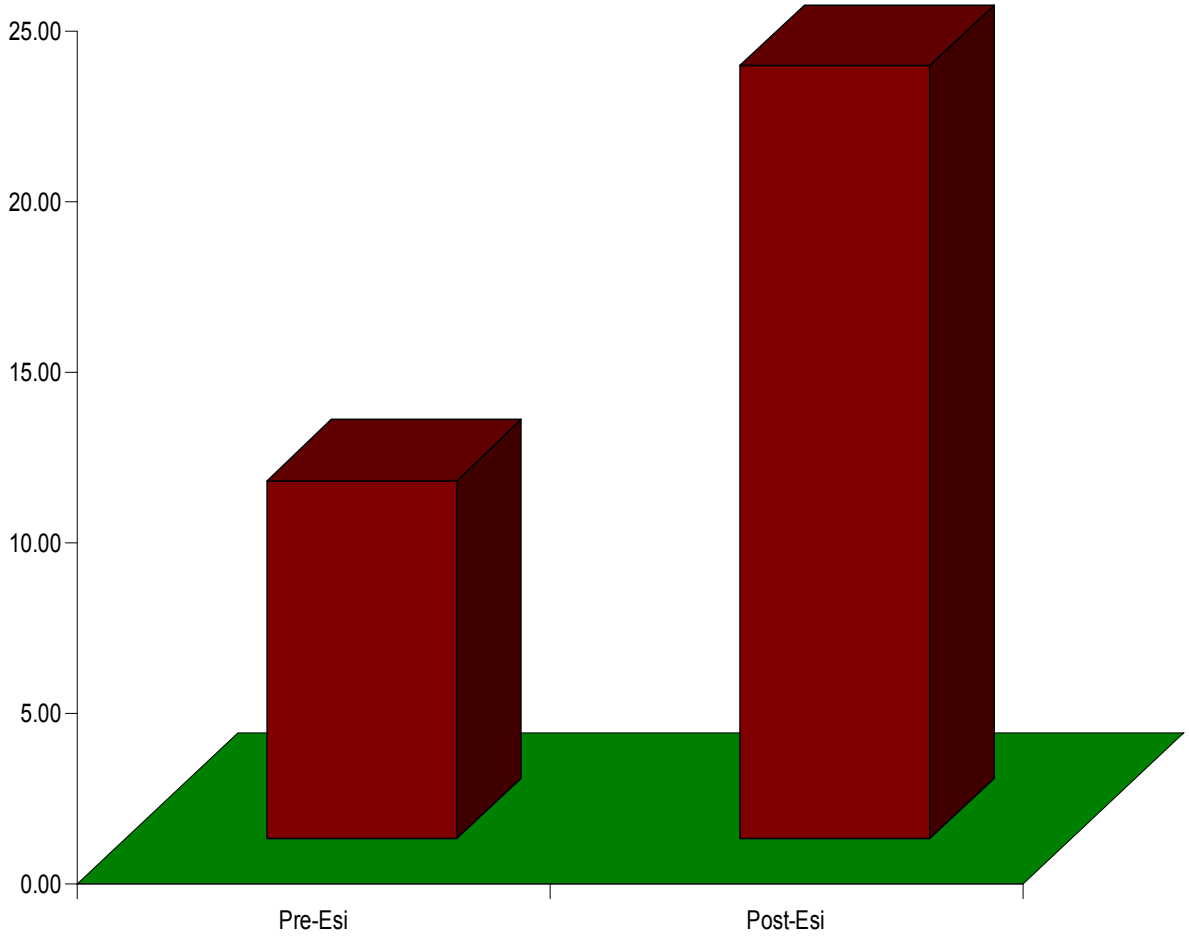


Figure 5: Mean of Pain Medication Groups

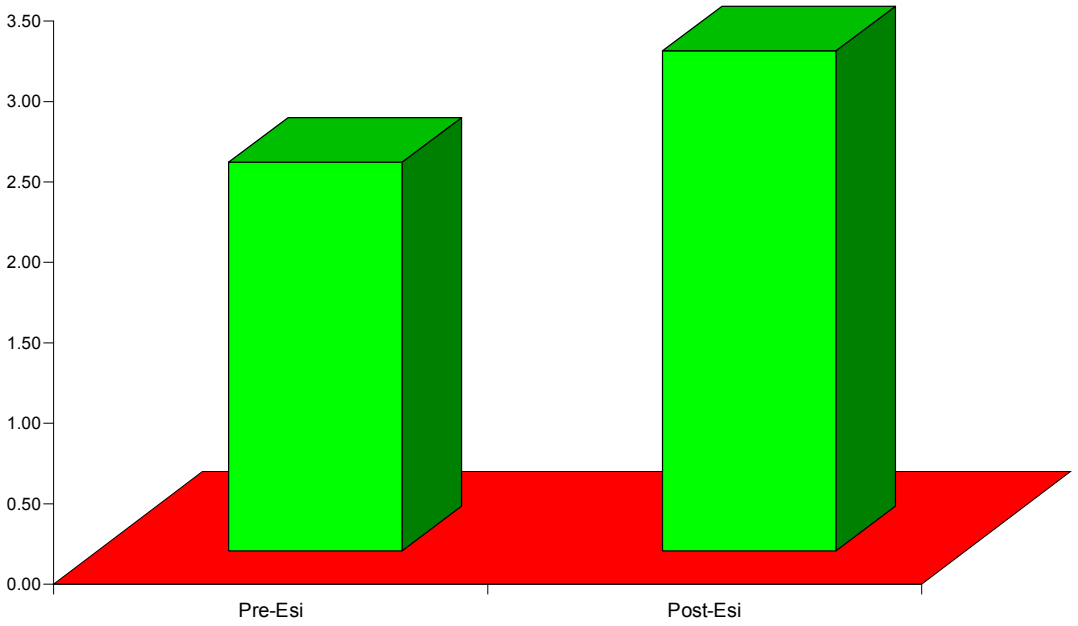


Table 3: Medication used for pain control Pre and Post ESI

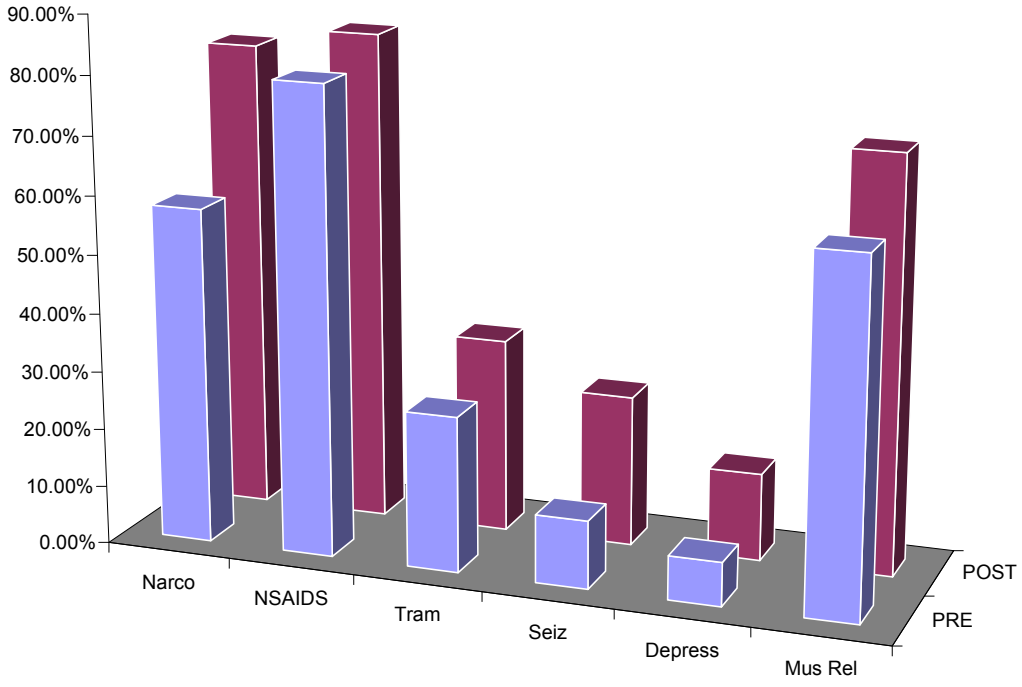
Medication	Pre -	ESI	Post -	ESI
	# Claimants	% Claimants	# Claimants	% Claimants
Narcotics	69	57.5%	97	80.83%
NSAIDS	96	80%	101	84.17%
Tramadol	32	26.67%	40	33.33%
Anti-seizure	15	11.67%	31	25.83%
Anti-depressant	8	7.5%	18	15%
Muscle Relaxant	72	60%	85	70.83%

In terms of medication use, 69 claimants (57.50%) used narcotics prior to ESI and

97 claimants (80.83%) used narcotics after ESI. 96 claimants (80%) used NSAIDS prior to ESI, and 101 claimants (84.17%) used NSAIDS after ESI. 32 claimants (26.67%) used to tramadol prior to ESI, and 40 claimants (33.33%) used to tramadol after ESI.

15 claimants (11.67%) used antiseizure medications prior to ESI, and 31 claimants (25.83%) used to antiseizure medications after ESI. 8 claimants (7.50%) used antidepressants prior to ESI and 18 claimants (15%) used antidepressants after ESI. 72 claimants (60%) use the muscle relaxants prior to ESI and 85 claimants (70.83%) used the muscle relaxants after ESI.

Figure 6: Percentage of Pain Medications from Six groups Pre and Post ESI



Use of pain medications from six different groups was considered. 21 claimants (17.5%) used the pain medications from one group prior to ESI and three claimants (2.50%) used to pain medications from one group post-ESI. 43 claimants (35.83%) used to pain medications from two groups prior to ESI and 27 claimants (22.5%) used pain

medications from two groups, post-ESI. 43 claimants (35.83%) used to pain medications from three groups prior to ESI, and 51 claimants (42.5%) used pain medications from three groups post-ESI.

12 claimants (10%) used to pain medications from four groups prior to ESI, and 32 claimants (26.67%) used to pain medication from four groups post-ESI. 1 claimant (0.83%) used pain medications from five groups prior to ESI, and 4 claimants (3.33%) used to pain medications from five groups post-ESI. 0 claimants (0%) used to pain medications from six groups prior to ESI, and 1 claimant (0.83%) used pain medications from six groups post-ESI.

Figure 7: Pain Medications used from how many Groups to Manage Pain Pre and Post ESI

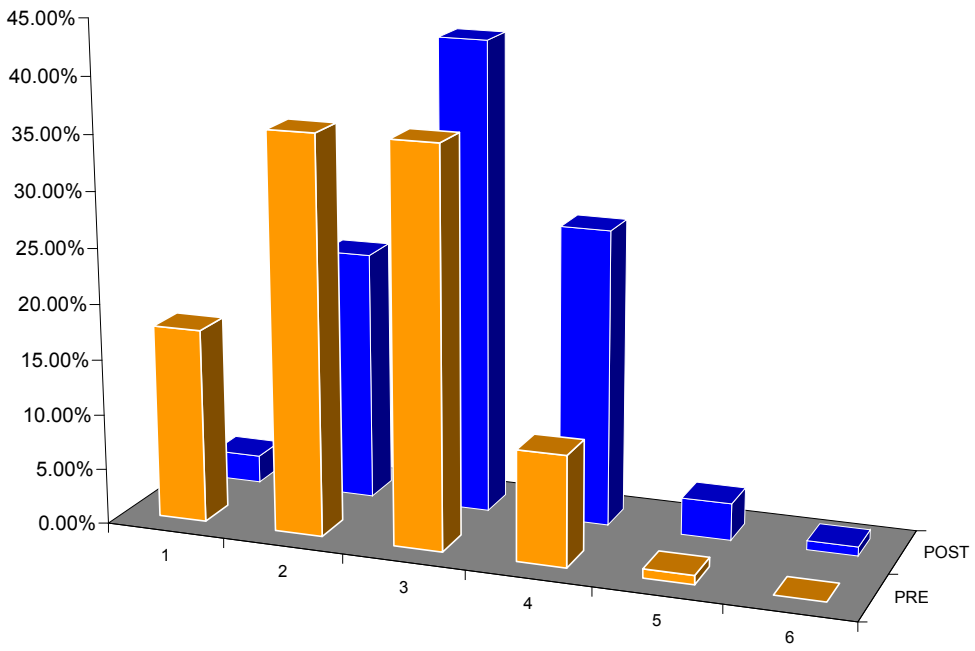


Table 4: Number of Medication Groups used to Manage Pain Pre-ESI and Post-ESI

Pain managed from how many medication groups	Pre - ESI		Post - ESI	
	# of Claimants	% of Claimants	# of Claimants	% of Claimants
1	21	17.50%	3	2.50%
2	43	35.83%	27	22.50%
3	43	35.83%	51	42.50%
4	12	10.00%	32	26.67%
5	1	0.83%	4	3.33%
6	0	0.00%	1	0.83%

Summary

All three outcome measures, namely, pain levels, morphine equivalent dose, and number of groups of pain medications were increased after ESIs.

Chapter V

Discussion

This study looked at the cost-effectiveness of ESIs in the treatment of lumbosacral radicular pain due to various levels of herniated nucleus pulposus. We demonstrated that at an average of 6.36 months after treatment with ESIs, there was an increase in subjective pain level based on the numerical pain scale. There was also a rise in medication use in all 6 groups of pain medications. Narcotic consumption standardized to a morphine equivalent dose was also increased.

The sample size was large enough for adequate power to detect clinically relevant differences in effects among outcome measures before and after ESI. The large sample size also allowed for unknown important prognostic variables to be in balance after randomization thus reducing bias (Koes et al., 1995).

Adequate injection technique and correct placement of the needle, plays an important role in the effectiveness of ESIs. This study used claimants' charts in which only fluoroscopically guided transforminal ESIs were performed, ensuring the best chance for effectiveness. Some studies have reported incorrect needle placement in considerable numbers of cases (up to 52% of procedures) depending on physician experience (el-Khoury, Ehara, Weinstein, Montgomery, & Kathol, 1988).

The majority of claimants (69%) suffered from 1 herniated nucleus pulposus followed by 24% suffering from 2 herniated discs and only 7% suffering from 3 herniated

discs.

There was a preponderance of males (80%) in this study and this is likely due to the fact that males in general, perform more physically strenuous tasks, placing them at increased risk for musculoskeletal injury. Patients who were receiving worker's compensation at baseline, were more likely to be young, male, and employed as laborers (S. J. M. D. Atlas, M.P.H.; Chang, Yuchiao PhD; Kammann, Erin M.S.; Keller, Robert B. M.D.; Deyo, Richard A. M.D., M.P.H.; Singer, Daniel E. & M.D>, 2000). An exception to this pattern was in a study on horse related musculoskeletal injuries where there was a preponderance of female injuries (Gimsing, 2001).

Disability compensation has always been associated with poor clinical outcomes (S. J. Atlas et al., 2006). The major pattern of the result observation is that of increasing medication use, pain and discomfort with time after ESIs in the workers' compensation population. This may be partly because chronic pain managed under workers' compensation, provide incentive such as financial gain to claimants, with a tendency for symptom prolongation. This is not unlike the findings of Carol A. Warfield who looked at 187 patients treated with ESIs for lumbar radiculopathy and found that ESIs worked better if the injury was not work related (Warfield & Crews, 1987).. Counter-effectiveness was most pronounced for extrusions, for which the steroid injection generated significantly higher medical costs and a greater likelihood of surgery (Karppinen et al., 2001)

In 1961, Henry Miller coined the term "accident neurosis" to describe a condition among workers whose pain did not follow any established pattern and which went away suddenly, after a settlement sum of money was collected (Miller, 1961).

Few studies have compared socioeconomic differences between those receiving and those not receiving workers' compensation with the same underlying clinical conditions. In one study, many socioeconomic characteristics significantly differed according to baseline workers' compensation status. Gender, educational level, work characteristics, legal action, and expectations about ability to work without surgery, were independently associated with receiving workers' compensation (S. J. Atlas et al., 2007).

In experimental pain studies, women have consistently displayed higher threshold and tolerance to pain induced by pressure, mechanical, and cold pressor stimuli (Inman et al., 2004). This factor could have contributed to the results of this study with males demonstration less coping strategies. Beliefs, attitudes, and recovery expectations appear to influence recovery from back pain (Gross et al., 2006).

Genetic factors with respect to collagen and individual variations in the expression of various molecules may play a pivotal role in the natural history of intervertebral disc herniations and one day may be a target for symptomatic control (Reyentovich & Abdu, 2002).

Another possible reason for the increase in pain level and medication use after ESIs may be due to complications. A Burton Report on ESIs suggested that increased pain after ESIs may be the result of adhesive arachnoiditis as a complication of synthetic steroid injection containing neurotoxic agents such as ethylene glycol and benzyl alcohol (Charles V. Burton, 2008).

Many studies have equivocal findings about the effectiveness of ESIs. One such study was conducted by Butterman et. al. and it was concluded that there is no

conclusive evidence to determine that ESI give lasting improvement (Buttermann, 2004a).

Similarly, in a review editorial published by the British Medical Journal, the authors pointed out that randomized controlled studies and systematic reviews of randomized trials have not shown convincing evidence that ESIs provide predictable relief of radicular pain (Samanta & Samanta, 2004). In a 1999 review of 13 studies published on the use of epidural steroids, 8 of the reviews showed no measurable benefit (Rozenberg et al., 1999).

Another study was conducted by Price et. al. in which 228 patients were treated with ESI and followed for cost-effectiveness. It was concluded that the procedure confers only transient benefit in symptoms for the treatment of radicular pain at substantial cost (Price et al., 2005). More recently the American Academy of Neurology, published an article by Armon et. al. stating that ESIs for chronic lumbar pain was not recommended (Armon et al., 2007).

Limitations

A limitation of this study is that data was abstracted by the principal investigator who was not blinded to the hypothesis. The methodological criteria, however, was quite strict and easy to apply.

Study Population

The choice of the study population was crucial to this study. Most studies on ESI have used samples drawn from the general population. This study used a sample drawn from the large database of a workers' compensation insurance company in the South-East

Region of the United States, and which serves approximately 40,000 small to medium-sized employers.

Comparison with Other Treatments

Glen R. Butterman, MD compared ESIs with discectomy for the treatment of lumbar disc herniation and found that patients who had undergone discectomy had the most rapid decrease in symptoms. It was concluded that ESIs was not as effective as discectomy with regard to reducing symptoms and disability associated with a large herniation of the lumbar disc (Buttermann, 2004b).

If left untreated, symptoms from herniated discs will resolve spontaneously. Studies show that 30 to 60% of people recover in one week, 60 to 90% recover in 6 weeks, and 95% recover in 12 weeks (Deyo & Weinstein, 2001), (Carragee & Hannibal, 2004). Patient education should focus on the natural history of the back pain, its overall good prognosis, and recommendations for effective treatment.

Food for Thought

When careful clinical observation and medical experience are combined with appropriate scientific studies, the best means by which valid conclusions can be drawn are then present. It is only by following this pathway can legitimate judgments regarding patient care be made and applied. Information, and the use of information varies widely in the lay and professional communities. Appropriate knowledge is not always present in health care. It is therefore imperative that patients know enough to ask the right questions of their care-givers (Charles V. Burton, 2008).

As remarkable as it seems there are actually primitive tribes in existence today who have not yet connected the act of sexual intercourse with the birth of a child nine

months later, it is equally remarkable that, at the same time, there are physicians providing high risk drugs and therapies to patients and have not yet connected the serious complications occurring months or years later with these therapies. This phenomenon has been termed the new guinea syndrome (Charles V. Burton, 2008).

Conclusions

This study has provided conclusive evidence that in the workers' compensation population, there are no long-term benefits to the use of ESIs in the treatment of lumbosacral radiculopathy in chronic pain patients, and that the back pain gets worse with time, regardless of cost of the procedure.

Recommendations

Further prospective studies are needed in the workers'compensation population regarding the use of ESIs, to better guide physicians on the use of evidence based medicine for the treatment of chronic pain, the long-term goals being reductions in claimants' discomfort from the procedure, and reductions in the national and global economic burden.

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