Optimal Anesthetic Techniques for Interventional Pain Procedures: Safety First
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Stem Case and Key Questions Content
A 60-year-old female is admitted to the hospital from the emergency department for intractable back pain and leg pain; her pain started 2 days ago as unrelenting, sharp shooting, unresponsive to over the counter medications. She gives a history of recent minor surgery and is convinced that her pain is due to the positioning during anesthesia and surgery; she demands to be evaluated by the anesthesiologist that performed her anesthetic, you. Upon admission to the floor, the hospitalist calls you in a pain consult for this patient.

Is this an appropriate consult? Are you going to evaluate the patient? Is there any information that you would need to have before you evaluate the patient? Is this an emergency?

Since you are also a pain physician and it happens that you are on pain consults, the patient is evaluated shortly. She is indeed in excruciating pain, unable to move due to 10/10 pain (on numerical rating scale-NRS) that starts in the mid-lumbar area and radiates in the groin and anterior thigh. She has a history of severe generalized anxiety and is on chronic alprazolam regimen. She blames you for not taking care of her during positioning and threatens to sue the hospital because the beds are so poor quality. She demands a STAT procedure (claims she had epidurals 2-3 years ago for similar complaints) to alleviate her pain. Upon examination you find an equivocal positive straight leg, subjective weakness and severe quadratus lumborum muscle spasm.

What would your differential be? Do you think her psychological component of pain is prevalent? Why and why not? What would you do next? Are you going to call the medical-legal department? Are you going to do a procedure? Why and why not?

Upon further discussions with the patient she agrees to an MRI of the lumbar spine. You start her on oral baclofen and intravenous morphine and her pain is somewhat better. You think you have a good plan for her care but when you start rounds with other patients, you are called STAT to the MRI.
because patient is incoherent and hysterical and starts hitting the MRI machine and the radiology technician.

What do you think is going on? Do you suspect any acute delirium in this patient? Why and why not? Which medication could have high suspicion for delirium? Is there other cause for patient’s behavior? Can her chronic anxiety be related to this state?

The patient admits that she had a severe panic attack triggered by the MRI machine and upon administration of an anxiolytic the imaging test is performed without any other incidents. The MRI results show a moderate disc herniation at L1-2 with associated spinal stenosis slightly increased in size since the previous exam 4 years ago. Her physical exam confirms now a significantly positive straight leg test at 15 degrees but no neurological deficit.

What is your next step? Are you planning a pain procedure right away? Are you going to try conservative regimen first? What would be the best course of action?

You plan to perform an epidural steroid injection at a later day as outpatient; however, patient becomes increasingly agitated and demands an injection immediately; she even tells you that in the past only transforaminal epidural steroid injections worked and advise you not to even try interlaminar since they were never successful in her case.

What would you do now? Are you going to take her suggestions? Are you going to discharge her from your care based on her behavior?

After much deliberation, you agree to perform the transforaminal but you explain that you would like to do it without sedation. Patient suddenly starts crying and claims that she had always had given her transforaminal while sedated with propofol and begs you to consult your colleague, her regular pain physician in the office who has been administering her procedures in the operating room for many years. You consult the electronic medical record that confirm her statements.

Would you continue with your original plan? Would you trick her into giving minimal sedation, conscious sedation or would you repeat what worked in the past and administer deep sedation? What would be the reasons for choosing one versus the other?

You decide that best would be a balanced conscious sedation and discuss it with your anesthesia colleague. However, while you are answering a page, the relief for your anesthesia colleagues, a temporary anesthesiologist in his first day at your institution, induces deep sedation with patient prone; you are shocked but he argues that the place he usually works for another pain practice, he always gives propofol. You start the procedure and after some difficulties you reach the L1 foramina;
upon aspiration of blood you reposition the needle and are ready to inject dexamethasone and lidocaine. Patient is in a state of deep sleep and starts desaturating; you have the needle in the patient back, ready to inject the medication when your anesthesia colleague yells that he needs to turn her on her back and intubate due to severe, persistent desaturation, significant hypotension and fear of losing the airway and the patient.

What would you do? Would you remove the needle? Would you rush and give the medication? You rush and reach for medication but in the action you inject quickly and use a syringe of triamcinolone and lidocaine that was on the field prepared for planned interlaminar injection. Patient's airway is appropriately supported; she is awakening from anesthesia 30 minutes later and reports no pain; however, she is unable to move her legs. She has significant sensory deficit in bilateral lower extremity to L1. She has 0/5 motor strength in her bilateral lower extremities.

What do you do now? Are you concern? Is there any reason for her not to regain motor function? Do you think her symptoms are related to the local anesthetic in the injectate, to the needle placement, to the steroid, to the adverse events from anesthesia?

2 hours after the injection, patient is still not moving her legs but the area of deficit is not progressing. You decide to order an MRI but the patient refuses unless you administer sedation. By the time the MRI with sedation is done another 3 hours passed. MRI done stat showed mild to moderate fluid accumulation suspicious for epidural hematoma and spinal infarct at L1 level.

What would you do now? Do you think that the fluid accumulation is a hematoma or your injectate? Would you call a surgical consultation? Do you think that deep sedation would have anything to do with this clinical development? Could you have done anything else to change this course of events? Would the type of epidural medication make any difference in developing a spinal infarct?

Neurosurgery decided to decompress the spine in an emergency procedure; intra-operatively, artery of Adamckiewicz is identified with no pulsatile flow; intra-operatively angiogram showed total occlusion of the artery; attempts to re-vascularize remain unsuccessful. Patient is discharged home 1 week later on anticoagulants and paraplegic; she never regained her lower extremity neurologic deficit. A medical-legal analysis identified that patient was on chronic Coumadin therapy which she did not disclose to anyone in the hospital; in addition, expert analysis identified that patient suffered the spinal infarct due to direct injection of the particulate steroid triamcinolone directly in the artery of Adamkiewicz coupled with severe and persistent hypotension and hypoxia during the deep sedation period. Prognosis was poor for recovery of the function.

Would you have done anything different? What are the chances for recovery of the neurological
function in the patient? Would a quicker surgical procedure be of benefit? If sooner intervention, how soon?

Model Discussion Content
Introduction
Patients are often afraid to agree to various procedures that alleviate chronic or acute pain for significant fear of aggravation of their symptoms. Therefore, in order to alleviate anxiety associated with various pain techniques and to improve patient satisfaction while treating chronic pain syndromes, pain physicians use various anesthetic techniques for interventional pain-relieving procedures. However, an important number of patients having to undergo pain relieving procedures have significant co-morbidities. Therefore careful choice of the anesthetic technique is of utmost importance in the balance between patient safety and satisfaction for successful treatment in chronic pain management.

History of interventional pain management
Many pain relieving techniques have been utilized for thousands of years, however it is only in recent years that modern medicine started to use interventional techniques to treat chronic, refractory or unrelenting pain. In addition, recent discovery and improvement of local anesthetic agents development and advances in neural blockade and regional analgesia. In 1884, Koller discovered that cocaine numbs the tongue.1,2 This observation prompted physicians to utilize this product in a variety of interventional techniques aimed to relieve pain such as caudal epidural injections3 (Cushing, 1901), trigeminal ganglion block4 (Schloesser, 1903), spinal anesthesia, epidural analgesia using loss of resistance techniques (Dogliotti, 1903). Next step in the development and modernizing of pain medicine as a medical specialty was the correct identification of pain generators. On those lines, many physicians started to employ interventional procedures and administer low dose of local anesthetics to various nervous structures and specific regions of the body in order to identify the source of pain. One of the first to attempt identification of pain arising from sympathetic and sensory nerves was von Gaza in 1924. He performed resection of the paravertebral nerves involved in angina pain only after bathing them with 10 ml of 0.5% procaine significantly reduced patients pain.5,6 Bonica’s extensive experience with diagnostic blockade and his and others constant quest for multidisciplinary interventional pain treatments, coupled with advances in the understanding of clinical anatomy and the structural basis of pain through Bogduk’s more recent studies, made pain interventions develop into complex, more advanced, lengthy procedures.7 Often those complex procedures required deep levels of sedation or general anesthesia. Balance between too much and too little sedation may significantly impact patient safety during pain procedures; therefore identifying the correct level of anesthetic for a certain pain procedure has been instrumental in development of the discipline of pain medicine.
Anesthesia techniques in off-site locations
The anesthetic techniques that are used for interventional pain-relieving procedures range from minimal or no sedation to general anesthesia. With the increase in the number and complexity of pain-relieving procedures, more are now performed in free-standing ambulatory surgery centers where anesthesiologists are available for care. Although anesthesia is not needed for simple pain interventions, a constant trend to improve patient satisfaction with pain relief prompts physicians to use sedation more often than in previous decades.8 In an already ailing patient population, anxiolysis and amnesia offered by sedation may distinguish one clinic from another and one physician’s practice. Sedation analgesia for a procedure relies on anxiolytics, sedatives, hypnotics or dissociative medications to decrease anxiety, pain or movement in patients.9 Although practice guidelines may differ in various regions 10, the American Society of Anesthesiologists (ASA) considers sedation a continuum and recognizes three levels of sedation. Those range from minimal where drug induced anxiolysis allows patient to respond normal to verbal stimuli, through moderate (conscious) sedation, where patient responds to verbal and tactile stimulation while he/she has a drug induced depression of consciousness without any impact on airways to, ultimately, deep sedation when patients develop a drug induced decrease of consciousness, are not easily aroused and respiratory function can be compromised. The most common agents used for sedation are opioids and benzodiazepines for their anxiolytic and amnesic effects. Other medications that maybe used in interventional pain procedures are ketamine, barbiturates, propofol, dexmedethomidine. Effects of some of those agents can relax muscles and maintain analgesia.11

Interventional pain-relieving procedures
Following an ascending trend in complexity and difficulty, interventions performed by trained pain physicians can range from a simple procedure in the office to a surgical case in an operating room. To align a patient’s expectations with the complexity of interventional pain-relieving procedures, physicians administer anesthesia to limit the anxiety, pain or emotions in patients who suffer from chronic pain. A brief description of common pain procedures and their anesthetic requirements is shown in Table 1.
The majority of in-office procedures (trigger points, joint injections, bursa injections) can be tolerated easily by patients without sedation and sometimes without skin infiltration by local anesthetic. Infusion treatments with lidocaine, or ketamine may require monitoring because of their side effects.

Intravenous lidocaine, which blocks sodium channels indiscriminately has been effective for several conditions: trigeminal neuralgia, diabetic neuropathy, fibromyalgia, cancer pain resistant to opioid therapy, and pain from spinal cord injury or central pain. Since lidocaine is a potent antiarrhythmic and can be associated with seizure activity, those procedures are performed by an anesthesiologist according to the ASA standards for monitored anesthesia care. Monitoring takes place for the duration of the infusion and recovery period. Doses may vary per protocol and range from 2 mg/kg to 5 mg/hr.

<table>
<thead>
<tr>
<th>Locations</th>
<th>Procedures</th>
<th>Additional imaging-fluoroscopy</th>
<th>Additional imaging-Ultrasound</th>
<th>Types of anesthesia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>Trigger points</td>
<td>No</td>
<td>No/Yes</td>
<td>None</td>
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<tr>
<td></td>
<td>Major/minor joint injections/Bursa injections</td>
<td>No</td>
<td>No/Yes</td>
<td>None/Local skin infiltration</td>
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<tr>
<td>Pain clinic procedure room/Ambulatory surgery center</td>
<td>Infusions (lidocaine/ketamine)</td>
<td>No</td>
<td>No</td>
<td>None/minimal/moderate sedation</td>
</tr>
<tr>
<td></td>
<td>Routine procedures: Epidual steroid injections, Transforaminal epidural steroid injections, Medial branch nerve blocks, etc</td>
<td>Yes</td>
<td>Yes/No</td>
<td>Local skin infiltration, +/- minimal sedation</td>
</tr>
<tr>
<td></td>
<td>Complex procedures: sympathetic chain blocks, discographies, gasserian ganglion blocks and RF, Minimally invasive lumbar decompression</td>
<td>Yes</td>
<td>No</td>
<td>Local infiltration, +/- minimal-moderate sedation</td>
</tr>
<tr>
<td>Surgery center</td>
<td>Kyphoplasty, Spinal cord stimulator, drug delivery system insertion</td>
<td>Yes</td>
<td>No</td>
<td>Local infiltration, Deep sedation, general anesthesia, regional anesthesia</td>
</tr>
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</table>
over various intervals (1 hour to 6 hours). In our institution we perform lidocaine infusion by delivering a 1mg/kg bolus followed by 4 mg/kg infusion over 30 minutes.

Ketamine, once a battlefield anesthetic interacts with a variety of receptor subtypes including opioid, N-methyl-D-aspartic acid (NMDA), GABA-A, and alpha-amino-3-hydroxy-5-methyl-4-isoxazole propionate (AMPA), that act in chronic pain states. Acting as an antagonist on centrally located NMDA receptors, ketamine is effective against neuropathic pain, cancer pain, fibromyalgia, opioid tolerance, diabetic neuropathy and headache.13,14 Because ketamine can produce hallucinations, pretreatment with midazolam and sometimes with fentanyl are indicated to reduce the side effects. With these medications, most patients are mildly to moderately sedated during infusion and may take up to 1 hour to recover after treatment. These infusions are administered in the office or in an ambulatory surgery center under the direct care of an anesthesiologist who applies ASA standard monitors. Doses administered range from 0.3 mg/kg/hr to 7 mg/kg/hr over periods of time that range from 30 minutes to 5 days and anesthetic levels ranging from minimal sedation to general anesthesia with endotracheal tube. In our institution we initiate ketamine infusions at 0.3 mg/kg over 30 minutes to be increased in subsequent sessions if necessary to maximum 1 mg/kg over the same period of time. Sedation for pain blocks that are performed in ambulatory surgery centers or in free-standing pain clinics is inconsistent across interventional pain settings.9 In United States, approximately 46% of interventional pain physicians recently surveyed use IV sedation for patients during routine lumbar steroid injections and up to 53% of the same responders use it in cervical epidural steroid injections.15 In many off-site anesthetizing locations, deep sedation is discouraged for routine pain-relieving procedures. For diagnostic procedures such as discography, selective nerve root block, or medial branch nerve blocks the added effect of opioids and benzodiazepines may alter the accuracy of the results and expose the patient to unnecessary more invasive procedures like radiofrequency ablation or spine surgery.

Some interventional pain-relieving procedures may be performed in the operating rooms with patients under deep sedation, regional or general anesthesia. Among such procedures are placement of a spinal cord stimulator and generator, implantation of an intrathecal drug delivery device and vertebral body augmentation (VBA) with kyphoplasty (KP) or vertebroplasty (VP).

The choice of anesthetic depends on the presence or absence of serious patient co-morbidities. Patients undergoing VBA are usually frail. Care is taken in positioning the patient for the procedure, and neurologic status is evaluated immediately after the procedure.16-19 There is no consensus on the type of anesthesia to be used for the VBA. The number of vertebrae to be treated in addition to consideration of patient co-morbidities affect the decision.

Active distention with the balloon during KP can be painful, and general anesthesia may be an option. VP may be performed with the patient under sedation; however, if the number of vertebrae treated...
exceeds three, a long operating time for a patient in an uncomfortable position may make general anesthesia preferable.

Patient co-morbidities and age favor local anesthesia and conscious sedation. In patients with advanced COPD and CO₂ retention, deep sedation can aggravate respiratory depression, worsen oxygenation, and increase the right ventricular afterload because of hypercapnia and pulmonary vasoconstriction. Regional anesthesia and analgesia may be better for these cases. With neuraxial short-acting local anesthetic agents and small doses of neuraxial opioids a VBA can be performed with light systemic sedation and maximum patient comfort.20-23 In our institution we perform balloon KP in the operating room to treat vertebral compression fractures. The patient is given mild sedation, and the vertebral pedicles are infiltrated with lidocaine 2% and bupivacaine 0.5%.

The most feared complication of VBA is cement extravasation. With a patient pain free from a general or regional anesthetic, cement leakage towards a nerve root or in a vessel can be easily masked. Using a slow injection with paste-like cement under direct fluoroscopic views from both postero-anterior and lateral positions may decrease the risk of devastating complications.

Complications related to anesthetic techniques in interventional pain procedures. With the constant growth in complexity and duration of interventional pain-relieving procedures, patients are often immobile for long periods. Although minimal or moderate sedation does not offer additional risk, deep sedation techniques have produced adverse events with devastating results for patients.

Despite a perfect fluoroscopic image, paresthesia from needle placement in neuraxium may alert the physician to needle malposition. The needle is redirected or the procedure is aborted. A patient under deep sedation, however, cannot trigger this safety signal and may awaken from the procedure gravely injured. Proximity to nervous structures and easiness of impaling or injury to those neighbouring structures is the primary reason why several diagnostic and/or therapeutic pain procedures (transforaminal epidural steroid injections, intrathecal catheters placement, spinal cord stimulators, discography, intradiscal ablative procedures, facet joint injections etc.) benefit from patient feedback. Airway compromise. The most serious complications from conscious sedation that progresses to deep sedation are respiratory and cardiovascular depression. Aggressive rescue measures are necessary immediately when such situations are recognized.9 For a patient who is in the prone position the ability to regain airway control is compromised especially when sedation is administered with hypnotic agents such as propofol by non-anesthesia trained personnel.24 Airway compromise associated with unrecognized high doses of hypnotic during sedation can induce a seizure-like phenomenon often associated with apnea and rapid desaturation.25 If propofol is administered during a procedure, minimal to moderate sedation states should be maintained with appropriate intravenous doses to prevent complications.8
Disinhibition and agitation. No cases of paradoxical agitation and hyperactivity during minimal sedations have been described. These states are often seen during deep sedation. Uncontrolled movements that appear with disinhibition during neuraxial needle placement can be associated with severe and devastating complications such as cord puncture, cord compression, or worsening of an already serious spinal stenosis. Agitation caused by a benzodiazepine can be quickly reversed with flumazenil; the propofol hyperexcitable state is controlled only by awakening the patient or inducing general anesthesia. In those situations more damage can be done making propofol a poor choice.

Predisposition to neural injury. Despite the safety of needle placement under fluoroscopic visualization during pain interventions, complications from malpositioning the needle within the spinal cord continue. An analysis of closed claims in anesthesia showed that claims associated with chronic pain cases are increasing, surpassing obstetric anesthesia claims. Among interventional pain procedures, cervical epidural steroid injections are associated with the most severe outcomes from needle malposition. In an analysis of the closed claims data from 2005-2008, Rathmell et al found that unfavorable outcomes from cervical interventions were more severe than adverse outcomes from all other interventions.

In depth analysis of the cases in malpractice claims showed that a traumatic spinal cord injury was present more often when patients had received deep sedation or general anesthesia or were unresponsive during the procedure.

Many patients undergoing interventional pain-relieving procedures, especially neuraxial injections, have spinal stenosis and are at risk for a severe neurological deficit if epidural pressure is increased. In an awake patient, pain upon epidural injection alerts the physician to decrease the amount of medication or to deliver the injectate more slowly while constantly communicating with the patient. In profound sleep states associated with deep sedation, however, the patient is unable to communicate discomfort. Devastating injuries such as more severe pain, loss of sensation, and sometimes paralysis may result.

The ability to perform a technically correct procedure may be blunted in a deeply sedated patient. When radiofrequency denervation is planned after diagnostic medial branch nerve blocks, correct placement of the needle is confirmed with sensory and motor stimulation. Although motor response from the multifidus muscle is possible in patients under deep sedation, radicular pain from a malpositioned needle may not be recognized. Injury to the nerve root during radiofrequency lesioning can go undiagnosed until the patient is awakened. Propofol is not the only culprit during such procedures.

Opioids, although essential in moderate sedation for their excellent analgesic effects, should be used rarely in diagnostic interventional procedures. The addition of intravenous fentanyl is relatively contraindicated for diagnostic procedures such as selective nerve root block, celiac plexus block, or...
discography. With fentanyl added it is unclear if pain relief is present because of the local anesthetic blockade or the intravenous opioid.

Adding anesthetics to interventional pain-relieving procedures to relieve anxiety and to comfort patients has proved to have mixed effects. With conscious sedation, short of severe psychiatric co-morbidities or a paradoxical reaction, pain-relieving interventions can be performed without the risk for adverse events. In a study of 2,494 patients that analyzed adverse events after conscious sedation in ambulatory spine procedures, there was no statistically significant difference in adverse events in patients who had pain-relieving procedures under local anesthetic alone or with local anesthetic and conscious sedation with midazolam.30

For diagnostic procedures that require long times and immobile patients conscious sedation, correctly administered with a patient responsive did not influence the results of the procedure. Manchikanti et al31 evaluated the effect of sedation on pain relief after diagnostic medial branch blocks in cervical and lumbar facet joints. Using identical methodology they found no significant difference between the sedation groups (sodium chloride, midazolam, fentanyl) or between anatomical regions treated (cervical, lumbar) and concluded that intravenous sedation with fentanyl or midazolam does not alter a patient’s response to a diagnostic block.9

Conclusion
Interventional pain-relieving procedures are becoming longer and more complex. Patients suffering from chronic, unremitting pain are often offered interventions during which they must be motionless. Anesthetic techniques are increasingly employed by pain practitioners in order to decrease patient anxiety and provide amnesia for interventional pain-relieving procedures. Varying from local anesthetic infiltrations to general anesthesia, techniques depend on patient co-morbidities and type of procedure. In general, routine pain interventions do not require additional sedation. When sedation is necessary conscious sedation is preferred because the patient is responsive and can alert to needle malpositioning. When general anesthesia is used in vertebral augmentation procedures, frequent fluoroscopic imaging limits the possible complications from cement extravasation.

As for diagnostic interventions, there is no consensus about the influence of sedation on accuracy and validity of the diagnostic procedure performed.9

Maintaining the balance between a patient’s comfort and safety influences the changes in the evolving field of pain management.
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