Multimodal therapy: allow Opiates: Etiologies: Failure of surgical pain management: Apfelbaum study (2003) — 80% of surgical patients surveyed noted pain in first 2 wk after surgery; 87% of those stated pain moderate to severe; ≈40% of patients had moderate to severe pain in immediate postoperative period; ≈25% noted significant side effects from pain medications (mostly opioids); complications — splinting; hypoxia; atelectasis; increased risk for pneumonia; hypertension and tachycardia (risk factors for cardiac ischemia and postoperative stroke); nausea and vomiting; ileus; muscle wasting; urinary retention; immunologic depression; possible tumor recurrence; anxiety and/or depression; posttraumatic stress disorder; chronic pain Etiologies: damage to nociceptive receptors at surgical site; release of inflammatory mediators; traction on internal organs; visceral pain; neuropathic pain from nerve damage; dynamic postsurgical pain; transmission pathways include rapid Aδ fibers and C fibers; multiple types of neurotransmitters and receptors transmit pain; plasticity of nervous system results in varied pain responses Opiates: cornerstone of pain therapy; benefits — inexpensive; effective for acute pain; have linear dose response, with no ceiling for analgesic effect; with adequate dosing, effective for almost any acute surgical pain Disadvantages: side effects and tolerance limit use; side effects — mediated by the same receptors that mediate analgesia (mostly μ receptors); include nausea and vomiting, somnolence, and constipation; have dose-response curve; each affects close to one-third of patients; ≈20% of patients develop urinary retention; ≤45% of elderly patients develop delirium; respiratory depression and ileus also seen; recovery can be delayed by either undertreatment of pain or use of opioids alone Multimodal therapy: recommended as best method for treatment of acute pain; additive and possibly synergistic effects of combination of analgesics (including opiates for postsurgical pain) allow improved analgesia with reductions in opioid doses, side effects, and postoperative complications Nonsteroidal anti-inflammatory drugs (NSAIDs): allow reductions of ≤30% in opioid use, incidence of nausea and vomiting, and sedation; acetaminophen — also decreases opioid use by ≤30%, but, by itself, does not decrease incidence of side effects; blocks production of neurotransmitting prostaglandins in spinal cord (while NSAIDs inhibit production of inflammatory-mediating prostaglandins peripherally); available orally and intravenously (IV; also true of ketorolac [Toradol]); precautions — reduce NSAID dose in patients >65 yr of age; avoid use if renal insufficiency, hypovolemia, myocardial disease, or gastrointestinal (GI) bleeding present, or if patient on anticoagulants; hospital study — no increase seen in incidence of complications when NSAIDS given regularly for ≤72 hr (safe in otherwise healthy patients); first-line addition to opiates; acetaminophen may be used in almost all patients (including elderly) without hepatic dysfunction or heavy alcohol use Steroids: have antiemetic, antipyretic, and analgesic properties; shown in several studies to improve analgesia and decrease opioid consumption after variety of surgeries; improve pain and recovery scores; well-being, and appetite after surgery; decrease opioid use by ≤30%; steroids (eg: dexamethasone [Decadron], methylprednisolone) have delayed onset but duration of action ≤72 hr; effective in treatment of dynamic pain; may decrease incidence of chronic pain after surgery; dosing starts at 0.1 mg/kg; precautions — avoid use in patients with history of GI bleeding; can cause increase in blood glucose and possible increase in cancer recurrence (conflicting data published) Ketamine: anesthetic analgesic; sites of action include μ, acetylcholine, and (most important) N-methyl-D-aspartate (NMDA) receptors in spinal cord and brain; NMDA receptors — involved in development of opioid tolerance; blocking receptor slows and may reverse tolerance; windup and central sensitization — secondary neurons in spinal cord fire at rate out of proportion to stimulus when intense or prolonged pain impulses received; these neurons recruit other neurons, thereby increasing perception of pain (may fire autonomously after stimulus diminishes); process inhibited by blocking of NMDA receptor; single bolus of ketamine (0.25-0.5 mg/kg) used as opioid substitute in short cases; however, most effective as infusion started intraoperatively and may be continued postoperatively (0.15-0.5 mg/kg/hr; higher doses may cause changes in mental status); highly effective in decreasing opioid use and improvement of analgesia in patients who require large amounts of opiates or are opioid tolerant; decreases incidence of nausea and vomiting Gabapentinoids: antiepileptic medications; bind to calcium channels in spinal cord; decrease fast firing of secondary neurons; effective for treatment of acute surgical pain (off-label use); opioid-sparing effect of ≤60% seen in multiple studies; available in oral form only; may decrease incidence of chronic pain; gabapentin — optimal dose unclear; good results achieved with

**Educational Objectives**

The goals of this program are to improve the management of acute pain and success rates of regional anesthesia. After hearing and assimilating this program, the clinician will be better able to:

1. Recognize the risks for poor outcomes associated with untreated pain.
2. Use multimodal therapy to relieve pain and decrease opioid consumption.
3. Evaluate the evidence supporting neuraxial regional anesthesia.
4. Determine the best approach for neuraxial procedures based on patient anatomy and characteristics.
5. Anticipate problems and risks that can lead to errors and patient injury during neuraxial procedures.

**Faculty Disclosure**

In adherence to ACCME Standards for Commercial Support, Audio-Digest requires all faculty and members of the planning committee to disclose relevant financial relationships within the past 12 months that might create any personal conflicts of interest. Any identified conflicts were resolved to ensure that this educational activity promotes quality in health care and not a proprietary business or commercial interest. For this program, members of the faculty and planning committee reported nothing to disclose. In their lectures, Drs. Shnider and Hardman present information that is related to the off-label or investigational use of a therapy, product, or device.
300 to 1200 mg/day; often given as single dose preoperatively; however, analgesia possibly improved beyond first 72 hr if continued postoperatively; pregabalin — 150 mg given preoperatively, then 1 to 2 times/day postoperatively for ≥2 days

α2-agonists: sedating, with analgesic activity; cause minimal respiratory depression; attenuate hemodynamic response to pain; clonidine — improves analgesia and decreases opioid consumption when added to spinal and peripheral nerve blocks; half-life of 9 hr limits intraoperative and immediate perioperative use; often used postoperatively in opioid-tolerant patients; desmedetomidine — more potent; has shorter half-life; given IV intraoperatively; decreases opioid use (and nausea and vomiting); highly effective in bariatric patients; side effects of hypertension and bradycardia may limit use. IV lidocaine: approved for chronic pain; has history of use in visceral and neuropathic pain, and off-label for acute pain; specifically improves analgesia, decreases opioid consumption, and shortens time to return of bowel function in colorectal, laparoscopic cholecystectomy, prostate, and possibly spinal surgeries; found ineffective for orthopedic and gynecologic surgery

Peripheral nerve blocks: used in combination with other analgesics; may allow avoidance of opioids, but usually combined with opioids and other analgesics; useful when epidural not possible (in, eg, outpatients); brachial plexus — provides excellent analgesia for upper extremity; paravertebral — used for breast surgery (may decrease incidence of recurrence of breast cancer) and for thoracotomies; improvement in respiratory mechanics same as with epidural vs patient-controlled analgesia (PCA); avoids hypotension and urinary retention; transversus abdominis plane (TAP) — useful in patients undergoing caesarian delivery under general anesthesia without intrathecal or epidural narcotics; lower extremity — used for pain control after knee and hip surgery; disadvantages — require special training to administer; time consuming (delay start of surgery); ultrasound (US) guidance — proficient clinicians have success rates ≥95%; US allows faster administration and onset, lower volumes of medication, and less patient discomfort; advantages of nerve blocks — decrease use of opioids and most side effects; patient satisfaction improved; decrease time to discharge when combined with aggressive rehabilitation; ≥24 hr analgesia obtained with single block, ≤72 hr with placement of catheter (infusion pumps allow patients to bolus for breakthrough pain)

Abdominal hysterectomy: preoperative — acetaminophen; gabapentin; intraoperatively — dexamethasone 0.1 mg/kg; small dose of fentanyl; ketamine infusion used for cancer surgery or opioid-tolerant patient; ketorolac one-half hour before end of surgery; TAP block before extubation; postoperatively — ketorolac continued; PCA given overnight; acetaminophen, oxycodone, and ketorolac on postoperative day 2

Chronic pain after surgery: ≤50% of patients undergoing thoracotomy have pain 1 yr after surgery; significant long-term pain seen in other surgeries; poorly managed acute pain and development of chronic pain strongly linked (although cause and effect not proven); small-scale studies show aggressive treatment of acute perioperative pain decreases incidence of chronic pain

Neuraxial Nightmares and Tuohy Tribulations

H. David Hardman, MD, MBA, Professor and Vice Chair, Department of Anesthesiology, University of North Carolina at Chapel Hill

Use of neuraxial procedures: Rogers study — meta-analysis demonstrated reduction in morbidity and mortality in patients receiving regional anesthesia (RA); over one-third in orthopedic subgroup (not large enough to show significant difference); however, superior pain control and reduced postoperative nausea and vomiting observed; Taiwan study — suggested that patients who had RA for total joint replacement less likely to have surgical site infection (odds ratio half that with general anesthesia); Mansudos study — suggested reduction in mortality and pulmonary and renal complications, but only 11% of patients treated strictly with neuraxial anesthesia; decline in use — likely due to shift to outpatient procedures, use of laryngeal mask airway, and lack of spinal agents with good recovery profiles; aggressive anticoagulation also limits use of RA

Thoracic and lumbar areas: thoracic vertebral bodies narrower and lamina wider than lumbar vertebra; transverse processes thicker in thoracic region; superior and inferior articulate processes oriented vertically in thoracic area and horizontally in lumbar region; spinous processes have prominent hooks in thoracic area, and more horizontal in lumbar area; pedicle connects vertebral body to lamina; spinal cord inside vertebral foramina under several layers; narrowing of area predisposes to compromise of cord, ischemia, or epidural hematoma in patients with spinal stenosis or other pathology

Neuraxial technique: midline approach — loss of resistance from ligaments felt when passing through ligamentum flavum; paramedian approach — no ligaments; less-used approach due to reduced positional awareness; facets vertically oriented (appear buried), intraluminal window smaller, and processes larger in thoracic than in lumbar spine (placement of needle more difficult)

Failed procedures: rate of spinal failures 11% in orthopedics; rate of epidural failures 5% in general surgery (mostly thoracic epidurals); technical — inability to enter the neuroaxis; inability to advance catheter in epidural technique; incorrect location; pharmacologic — inadequate dosing; problems with mixing

Difficulty entering neuroaxis: Attalla study — inability to feel bony landmarks and radiologic characteristics of lumbar spine (osteophyte formation and calcification of interspinous ligaments) predicted difficulty of performing spinal anesthesia; no difference seen between residents and attending anesthesiologists; obstetric study — inability to feel landmarks, spinal deformity, and inability of patient to flex back predicted difficulty of procedure; obesity and experience level of operator not independent risk factors (however, resident staff had substantial experience)

Difficult epidural: definitions based on studies — >1 skin puncture (occurred in 30% of population); >10 needle passes in orthopedic population; procedure longer than 400 sec; first-attempt success rates — very low with large body mass index (BMI), scoliosis, or previous surgery to lumbar spine; accomplished with fewer needle passes when US guidance used (but no difference seen in overall success rate); common errors — misidentification of interspace level (only 30% correct); level more cephalad than supposed in >50%; video study — errors included repeating previously failed maneuvers, insertion angles with low probability of success, and underestimating number of attempts

Neurologic injury: needle placement and accurate identification of interspace levels important due to variation in level of conus medullaris; cords end below L1 in most adults, but may be as high as T12 or low as S1; French study — patients with severe permanent injury after neuraxial procedure more likely female and elderly; most had undiagnosed anatomic abnormalities, rather than injuries due to technical difficulties (eg, hematoma)

Changes in spine with older age: scalloping or collapse of vertebral body; osteophytes on spinous processes; degenerative changes in facet joints limit ability to flex spine; compression of discs collapses disc space (affects midline approach); paramedian approach possibly better (provides larger window); lateral decubitus position — small study found success rate of 85% (vs 40%); possibly easier in patients unable to flex back

Obesity: increases difficulty of finding bony landmarks; ability to feel landmarks more predictive than actual BMI; presents difficulties with positioning; US helpful

Previous spinal surgery: Mayo Clinic study — studied patients with underlying neurologic abnormalities (eg, peripheral neuropathy, radiculopathy, previous spinal surgery); success rate in those
with past spinal surgery (97%) similar to that with no previous surgery; no differences seen in rates of neurologic complications (1.1%); however, most patients in study had laminectomy rather than spinal fusion, and complication rate substantially higher than current risk for nerve injury with neuraxial anesthesia

**Scoliosis:** for Cobb angle <25°, catheter can be easily placed if positioning good; approach spine from convex side if angle greater; consider paramedian approach; use imaging or US; consider fluoroscopy with severe scoliosis; remember proximity of kidneys; rotational changes may affect location of foraminal and emergence point of peripheral nerve root (increasing risk for nerve injury)

**US guidance:** allows more accurate determination of interlaminar level, fewer needle passes, higher first-attempt success rates, and shorter procedure times; useful for patients in whom landmarks difficult to find; technically more difficult than use for peripheral nerve blocks; usefulness generally limited to lumbar area; experience with normal backs recommended before attempting in problem back; lumbar US—facets prominent, with transverse process; chance of successfully entering neuraxis 85% if "smile sign" visualized on imaging

**Clinical pearls and tips:** plan ahead; allow sufficient time for patients with difficult backs; consider peripheral nerve block as alternative; review past medical records and previous imaging; request help from more experienced colleague, if needed; proper positioning critical; use clear transparent drape; use marking pen to identify anatomy; use US to plan approach if landmarks poor; consider paramedian approach; have systematic plan for needle placement; consider using larger needle, especially if interspinous ligaments calcified and scarred (cutting edge may be needed); limit time or number of approaches

---

**Acknowledgements**

Dr. Shnider was recorded at Perioperative Management, held March 9–12, 2014, in Marco Island, FL, and sponsored by the Johns Hopkins University School of Medicine and the Office of Continuing Medical Education. Dr. Hardman was recorded at the 19th Annual Advances in Physiology and Pharmacology in Anesthesia and Critical Care, held October 26–29, 2013, in Hilton Head Island, SC, and sponsored by Wake Forest School of Medicine, Department of Anesthesiology, Winston-Salem, NC. For information on upcoming CME meetings sponsored by the Johns Hopkins University School of Medicine, please visit hopkinscme.edu. For meetings from Wake Forest University School of Medicine, Department of Anesthesiology, please go to wakehealth.edu/anesthesiology. The Audio-Digest Foundation thanks the speakers and the sponsors for their cooperation in the production of this program.

---

**Suggested Reading**


**Accreditation:** The Audio-Digest Foundation is accredited by the Accreditation Council for Continuing Medical Education to provide continuing medical education for physicians.

**Designation:** The Audio-Digest Foundation designates this enduring material for a maximum of 2 AMA PRA Category 1 Credits™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

The American Academy of Physician Assistants (AAPA) accepts certification for educational activities designated for AMA PRA Category 1 Credit™ from organizations accredited by ACCME or a recognized state medical society. Physician assistants may receive a maximum of 2 AAPA Category 1 CME credits for each Audio-Digest activity completed successfully.

Audio-Digest Anesthesiology Volume 56 – This program has been prior-approved by the American Association of Nurse Anesthetists (AANA) for 48 CE credits; Code Number 1028828; Expiration Date 12/31/15.

Audio-Digest Anesthesiology Volume 55 – This program has been prior-approved by the AANA for 48 CE credits; Code Number 1027315; Expiration Date 12/31/14.

CRNAs must earn a score of 80% to receive credit, and are not permitted to retake, as per the AANA.

CRNAs may earn 1 credit per issue in Volume 56 from January 1, 2014 to December 31, 2015.

Audio-Digest Foundation is accredited as a provider of continuing nursing education by the American Nurses Credentialing Center’s (ANCC’s) Commission on Accreditation. Audio-Digest designates each activity for 2.0 CE contact hours.

Audio-Digest Foundation is approved as a provider of nurse practitioner continuing education by the American Academy of Nurse Practitioners (AANP Approved Provider number 030904). Audio-Digest designates each activity for 2.0 CE contact hours, including 0.5 pharmacology CE contact hours.

The California State Board of Registered Nursing (CA BRN) accepts courses provided for AMA category 1 credit as meeting the continuing education requirements for license renewal.

**Expiration:** The CME activity qualifies for Category 1 credit for 3 years from the date of publication.

**Cultural and linguistic resources:** In compliance with California Assembly Bill 1195, Audio-Digest Foundation offers selected cultural and linguistic resources on its website. Please visit this site: www.audi digest.org/CLCResources.

**Estimated time to complete the educational process:**

- **Review Educational Objectives on page 1**
  - Take pretest
  - Listen to audio program
  - Review written summary and suggested readings
  - Take posttest
  - 5 minutes
  - 10 minutes
  - 60 minutes
  - 35 minutes
  - 10 minutes
1. According to a study of postsurgical pain management, which of the following statements is true?
   (A) 30% of patients had pain in the first 2 wk after surgery
   (B) 87% of patients with postoperative pain rated it as mild
   (C) Poorly treated surgical pain can increase the risk for pneumonia or postoperative stroke
   (D) The incidence of side effects from postoperative pain medications is <10%

2. Select the true statement about use of opioid medications for postoperative pain.
   (A) Dose response is linear
   (B) Different receptors mediate analgesic and side effects
   (C) Cause nausea and vomiting, somnolence, and constipation in ≈15% of patients
   (D) Analgesic effects reach a ceiling when doses repeatedly increased

3. When acetaminophen alone is added to opiates, the incidence of side effects is:
   (A) Reduced
   (B) Eliminated
   (C) Unchanged
   (D) Increased

4. Which of the following statements about the anesthetic analgesic ketamine is true?
   (A) Increases incidence of nausea and vomiting
   (B) Slows opioid tolerance and blocks windup and central sensitization
   (C) Recommended for intraoperative use only
   (D) Recommended infusion dose is 1.0 mg/kg/hr

5. Which of the following statements about peripheral nerve blocks is not true?
   (A) Require special training to administer
   (B) Use of ultrasound (US) guidance associated with lower medication volumes and decreased pain during treatment
   (C) Use with rehabilitation decreases time to discharge
   (D) Effective analgesia is limited to 24 hr

6. Studies suggest that neuraxial procedures for regional anesthesia:
   (A) Are being increasingly used
   (B) Provide superior pain control
   (C) Have no effect on morbidity or mortality
   (D) Are associated with increased rates of surgical site infections

7. The _______ approach to the neuraxis does not pass through any ligaments; vertebrae in the _______ region have larger interlaminar windows, which facilitate needle insertion.
   (A) Paramedian; thoracic
   (B) Midline; thoracic
   (C) Paramedian; lumbar
   (D) Midline; lumbar

8. According to studies of patients who received regional anesthesia, which of the following are independent risk factors for failure to enter the neuraxis?
   1. Operator experience
   2. Inability to feel landmarks
   3. Patient obesity
   4. Radiologic characteristics (eg, osteophyte formation)
   5. Inability of patient to flex the back
   (A) 1,2
   (B) 3,4
   (C) 1,3,5
   (D) 2,4,5

9. A study of elderly patients who sustained severe neurologic injury while undergoing neuraxial procedures showed that most injuries were related to hematomas due to technical problems during the procedure.
   (A) True
   (B) False

10. The use of US guidance during neuraxial procedures:
    (A) Has the same technical difficulty as peripheral nerve blocks
    (B) Is equally useful in lumbar and thoracic regions
    (C) Prolongs procedure time
    (D) Helps identify interlaminar levels

Answers to Audio-Digest Anesthesiology Volume 56, Issue 27: 1-C, 2-B, 3-C, 4-B, 5-A, 6-A, 7-C, 8-D, 9-D, 10-A