Regional Anesthesia for the Upper Extremities

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Purpose of upper extremity (UE) blocks: studies of ambulatory procedures show regional anesthesia (RA) consistently provides improved analgesia, decreased opioid-related side effects, faster discharge to home, and decreased incidence of unplanned admissions, compared with general anesthesia (GA); advantages of RA over GA seen only during first 24 hr; RA shows improved pain control, compared with pain pump continuous infusion systems or intraarticular injections

Optimizing success of UE RA: literature suggests all localization techniques (eg, paresthesia, nerve stimulation, ultrasound-guided [USG]) offer virtually identical success rates of 90% to 95%

Number of injections: location of terminal nerves relative to axillary artery varies widely; multiple injections improve success of axillary nerve blocks (2 or 3 injections improve success over single injection with paresthesia or nerve stimulator techniques; 4 injections adds time without improving success rate); posterior compartment (radial nerve) most important of 4 possible locations, followed by median and musculocutaneous nerves (ulnar nerve least important)

USG: success rate with 2 injections (musculocutaneous and 6 o’clock position behind artery) equal to that with 3 injections, with shorter procedure time, fewer needle passes, and less pain for patient

Infraclavicular block: due to variation in location of cords around axillary artery, 2 injections required to improve success when using paresthesia or nerve stimulator techniques; first injection should be directed toward posterior cord, and second toward either lateral or medial cord

Single injection (or catheter insertion) with USG: should be near posterior cord

Continuous perineural catheters: advantages — duration of block extended; analgesia improved over oral opiates, with reduced side effects; not associated with increased risk for complications; “soft outcomes” (eg, sleep, patient satisfaction) improved; concerns — value of increased cost vs benefit; third-party payers may refuse payment for use in low-to-moderate pain procedures because evidence for improved rehabilitation inconclusive

Selective blocks: used for procedures outside of coverage by brachial plexus block: suprascapular nerve — supplies posterior two-thirds of shoulder joint; block beneficial for shoulder arthroscopy with GA (supplements area of posterior port), and useful for rescue from persistent pain in patients with interscalene block; intercostobrachial nerve — energizes upper medial portion of upper arm; block useful for revision of arteriovenous fistula, decreases pain associated with tourniquet use, and supplements anterior axilla after successful interscalene block

Local anesthetics: effect of drugs often different when applied to neuraxial vs peripheral nerves; increased dose increases duration of spinal blockade; no local anesthetic ideal for brachial plexus block (choice of agent based on individual comfort level and desired duration of blockade; match duration of local anesthetic to estimated duration of severe pain after surgery)

Dosage: mass of drug (concentration multiplied by volume) key factor in local anesthetics; data consistently show identical onset, intensity, and duration of axillary blockade with various volumes and concentrations (ie, higher concentrations and volumes do not improve block quality); advantages of lower concentration — decreased risk for peripheral nerve damage from needle; decreased risk for anesthetic toxicity with intravascular injection; USG techniques — allow for lower doses of local anesthetic; however, very low doses (eg, 0.8 mL) significantly decrease duration of blockade

Adjuvants: offer little benefit; most effective on intermediate-acting agents (eg, mepivacaine, lidocaine); with long-acting agents (eg, bupivacaine, ropivacaine), prolong effect by ≤20% (usually, by ≤10%); for long-acting blocks, use long-acting agents, rather than intermediate-acting agents with adjuvants; epinephrine — best adjuvant; readily available, inexpensive, prolongs action of intermediate drugs by ≥50%, and acts as marker of intravascular injection (only adjuvant that aids in preventing local anesthetic toxicity); higher doses cause tachycardia and reduce blood flow at peripheral nerves; negative effects minimized with use of 1:400,000 concentration rather than standard 1:200,000 concentration; clonidine — equivalent to epinephrine for prolongation of local anesthetics, but relatively expensive and provides no intravascular marking; buprenorphine — increase in duration of blockade similar to that with epinephrine, but risk for postoperative nausea and vomiting somewhat increased; dexamethasone — few high-quality studies available; some studies show extreme prolongation of blockade, which raises concern for subclinical nerve damage (anti-inflammatory effect decreases blood flow around nerve, thereby decreasing clearance of local anesthetic; injury results from concentration of

Educational Objectives

The goals of this program are to increase the safety and effectiveness of upper extremity regional anesthesia (RA) and improve transfusion practices. After hearing and assimilating this program, the clinician will be better able to:

1. Select techniques that optimize the success of upper extremity RA.
2. List the risks and benefits of common adjuvants to local anesthetic agents.
3. Minimize the risks associated with RA.
4. Choose an appropriate hemoglobin level as a trigger for intraoperative transfusions.
5. Effectively use massive transfusion protocols to maximize survival in actively bleeding trauma patients.

Faculty Disclosure

In adherence to ACCME Standards of 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, the faculty and planning committee reported nothing to disclose.
Complications of RA: Transfusion of red blood cells (RBCs): Transfusion practices: Anemia and mortality: Current Transfusion Practices

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History of transfusion: first transfusion attempt in 1667 with lamb’s blood; James Blundell later improved maternal survival with transfusion; Karl Landsteiner described ABO system; accidental spinal injection: risk highest with interscalene blocks; respiratory complications: phrenic nerve frequently involved; local anesthetic and duration of exposure; animal studies suggest increased risk in diabetic patients; speaker recommends using local anesthetic without adjuvants when placing blocks in these patients; dexamethasone - AESH initial studies show favorable toxicity in animals; clinical studies currently underway; appears useful as adjuvant, but expensive; provides slightly longer block than epinephrine; other adjuvants - not recommended (ineffective, not well studied, or cause neurotoxicity)

Alkalization: sodium bicarbonate added to epidural solution speeds onset of block by ≈5 min; however, this effect not observed with peripheral nerves (when added to lidocaine or mepivacaine, does not change onset of block, and decreases duration and intensity); neutralizes pH when added to premixed solution of lidocaine and epinephrine, but speeds onset by only ≈1 min

Complications of RA: spinal anesthesia presents high risk for severe complications (eg, cardiac arrest, death), compared with epidural or peripheral nerve block; however, likelihood of seizure 4 to 5 times greater with peripheral nerve block than with epidural; risk for nerve injury greater with spinal and epidural blocks than with peripheral nerve blocks

Respiratory complications: phrenic nerve frequently involved when UE blocks placed; hemidiaphragmatic paralysis occurs in ≈100% of patients when paresthesia and nerve stimulation, compared with epidural technique used, with some patients experiencing 25% to 30% reduction in pulmonary function; therefore, above-clavicle blocks contraindicated for patients receiving supplemental O₂ at home; with supraclavicular approach, phrenic nerve involvement decreases to ≈50%, with minimal risk to spirometric function; causes of phrenic nerve involvement — high-volume injections (nerve stimulator); close proximity of phrenic nerve to site of injection (USG); although lower volumes decrease intensity and duration of phrenic nerve blockade, occurrence remains unpredictable; pneumothorax — likely related to technique; incidence decreased, but still possible, with USG technique

Seizure: risk particularly high in UE blocks because needle in close proximity to vessels directly supplying brain; patients tend to seize quickly, but stop when injection halted

Accidental spinal injection: risk highest with interscalene blocks; USG technique has reduced risk; manifested by sudden development of hypotension and bradycardia (sedated patients may not report bilateral and/or lower extremity numbness); death results when condition unrecognized or incorrectly treated; patient requires volume, atropine, and epinephrine (epinephrine drug of choice if patient does not respond rapidly)

Needle injury: transection of nerve very rare; if needle disrupts perineurium and fascicles, denuded nerve damaged by direct exposure to local anesthetic (if anesthetic combined with epinephrine, clearance decreased)

American Society for Regional Anesthesia and Pain Medicine practice advisory: cautions against use of interscalene blocks in asleep or deeply sedated patients (due to case reports of spinal cord injuries)

Anemia and mortality: survival rates lower in patients with preoperative anemia than in those without anemia; generally, identification of patients with anemia does not occur sufficiently far in advance of surgery to allow significant improvement of red blood cell stores; overall mortality increased by ≈1.5% in patients anemic on day of surgery; transfusion of anemic patients does not improve survival (best survival seen in patients [both anemic and nonanemic] who did not receive transfusions)

Transfusion practices: vary widely among institutions, with best survival rates in institutions with most restrictive transfusion practices; case report — patient with multiple stab wounds and no crossmatched blood available; had hemoglobin (Hb) nadir of 0.7 g/dL; circulation supported with large volume of hydroxyethyl starch until blood became available; patient showed no evidence of end-organ ischemia

Transfusion of red blood cells (RBCs): common procedure; textbooks recommend administration of RBCs when oxygen supply inadequate; however, inadequacy rarely proven before administration of RBCs (accurate test for assessing regional hypoxia lacking); despite these limitations, transfusion remains vital component of armamentarium; World Health Organization being asked to add RBCs to list of medicines essential for world health

Transfusion protocols: transfusion threshold of <10 g/dL Hb generated from study of elderly patients with active myocardial infarction (MI); however, most perioperative patients not experiencing thrombus-induced MI, so information not applicable; Transfusion Requirements in Critical Care (TRICC) — compared restrictive transfusion strategy (trigger of Hb <7 g/dL) with liberal strategy (trigger of Hb <9 g/dL); results showed higher mortality in patients treated with liberal strategy and 54% drop in transfusions with restrictive strategy; among less severely ill patients, treatment with liberal strategy associated with one additional death for every 13 patients treated (for more severely ill patients, one death for every 14) than in restrictive strategy arm; multiple studies support restrictive therapy in patients in intensive care unit, undergoing coronary artery bypass grafting (CABG), or having hip surgery; no differences seen in recovery outcomes between transfusion with Hb level of 8 vs 10 g/dL; in patients with active upper gastrointestinal bleeding, survival 4% to 5% better with restrictive strategy of Hb 7 g/dL than with more liberal transfusion; findings partially explained by increase in bleeding often seen after transfusion of RBCs; preoperative transfusions — indicated in some instances; require well-functioning preoperative system and cooperative, well-informed surgeons; in CABG procedures, associated with reduced incidence of postoperative renal dysfunction (prevents spike of free iron during tissue reperfusion)

Trauma: risk for multisystem organ failure increases if high volume of RBCs transfused without concomitant fresh frozen plasma (FFP); hemorrhage most common cause of death in early stages of trauma, and multisystem organ failure most common in later stages; massive transfusion protocol aids clinical management in acute situations; ratio of FFP to RBCs affects outcomes in trauma patients; low ratio (mainly RBCs) in early resuscitation decreases survival rate (data corrected for “survivor bias” [ie, patients who die quickly due to hemorrhage do not have opportunity to receive FFP]); ongoing research indicates patients benefit from near-whole blood during early resuscitation (protocols expected to change in coming years)

Stable anemia: rate of death higher in patients who received transfusions than in those not transfused; common situation in patients presenting for surgery; clinician must determine rate of blood loss and assess circulatory function to determine whether transfusion truly needed (rather than giving it out of habit) to avoid harm
American Society of Anesthesiologists guidelines: not helpful; state that transfusion of RBCs necessary if Hb < 6 g/dL and unnecessary if Hb > 10 g/dL; recommendations lag behind current literature on transfusions and coagulopathy (ie, recent data support avoiding development of coagulopathy during acute blood loss in severe trauma rather than treating it after it develops)

Patient blood management: finding ways to reduce bleeding, improve anemia before arrival at operating room, improve blood salvage, and limit transfusion of nonautologous blood

Alternatives to RBCs: use lower transfusion triggers and conserve blood in operating room (eg, cell salvage, normovolemic hemodilution); all research with HB-based oxygen carriers unsuccessful to date (due to exposure to free iron);

Suggested Reading


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Estimated time to complete the educational process:

- Review Educational Objectives on page 1: 5 minutes
- Take pretest: 10 minutes
- Listen to audio program: 60 minutes
- Review written summary and suggested readings: 35 minutes
- Take posttest: 10 minutes

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1. All the following are true of regional anesthesia (RA) for upper extremity procedures, except:
   (A) Benefits of RA over general anesthesia (GA) persist beyond first 48 hr after surgery
   (B) Pain control superior to that with pain pump continuous infusion systems or intraarticular injections
   (C) Discharge to home faster than with GA
   (D) Allows reduction in opioid-related side effects

2. When performing an axillary block, which of the following nerves should be the target of the first injection?
   (A) Ulnar  (B) Musculocutaneous  (C) Radial  (D) Median

3. Which of the following is an advantage of continuous perineural catheters?
   (A) Decreased overall cost  (B) Improved rehabilitation and long-term outcome  (C) Ease of placement  (D) Improved “soft outcomes”

4. Which of the following adjuvants to local anesthetics has been shown to increase postoperative nausea and vomiting?
   (A) Buprenorphine  (C) Dexamethasone
   (B) Dexmedetomidine  (D) Clonidine

5. There is a much greater risk for _______ with peripheral nerve blocks than with epidural or spinal blocks.
   (A) Cardiac arrest  (B) Seizure  (C) Nerve injury  (D) Death

6. Transfusion of patients with preoperative anemic improves survival.
   (A) True  (B) False

7. Recent literature indicates the trigger for transfusion of red blood cells (RBCs) should be revised to a hemoglobin (Hb) level of:
   (A) 5 g/dL  (B) 7 g/dL  (C) 9 g/dL  (D) 11 g/dL

8. Select the true statement about management of trauma patients.
   (A) Administering fresh frozen plasma in the early stages of resuscitation increases the risk for multisystem organ failure
   (B) Transfusion protocols for the acute phase of trauma management direct delaying transfusion until accurate Hb levels are established
   (C) Hemorrhage is the most common cause of death in the early stages of trauma, and multisystem organ failure is most common in later stages
   (D) Research indicates that whole blood should be avoided in early resuscitation

9. “Patient blood management” refers to the process of monitoring Hb levels, crossmatching blood, and transfusing blood components for each individual patient.
   (A) True  (B) False

10. All the following are techniques that lower the need for transfusion of RBCs, except:
    (A) Use of lower transfusion triggers  (C) Normovolemic hemodilution
    (B) Cell salvage  (D) Hypothermia

NOTE: On Audio-Digest Anesthesiology Volume 55, Issue 45, the correct answer to question 6 is “A.”

Answers to Audio-Digest Anesthesiology Volume 56, Issue 01: 1-C, 2-B, 3-B, 4-A, 5-D, 6-D, 7-A, 8-D, 9-A, 10-C

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