Transfusion Practices 2012
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Clinical findings
Anemia: in 2009, Beattie and colleagues showed association between low preoperative hemoglobin level and increased risk for perioperative mortality; transfusion further increases risk; best solution — treat anemia before patient comes to surgery (usually impractical)
Coronary artery bypass grafting (CABG): likelihood of patient receiving transfusion varies from 20% to 80%, depending on institution (policies not consistent); across United States, 20% of transfused blood administered in association with cardiovascular surgery
Management of patient with severed axillary artery: transfusion administered when hemoglobin reached 0.7 g/dL, patient showed no signs of ischemia and recovered uneventfully; case emphasizes lack of standard transfusion trigger; indication should be need to increase oxygen-carrying capacity of blood; no reasonable test for tissue hypoxia currently exists
Transfusions in patients with acute coronary syndromes and myocardial infarction: study showed that transfusion reduced mortality if hematocrit <30%; had no effect when hematocrit >33%; applies only to patients with acute coronary syndrome or myocardial infarction, but used more widely; evidence suggests transfusion policies for critical care patients should be more restrictive; in trial of patients in intensive care unit (ICU), liberal transfusion policy (hemoglobin <10 g/dL) associated with one death for every 15 patients; mortality lower with restrictive policy (hemoglobin <7 g/dL); similarly, transfusion appears to decrease survival among patients undergoing CABG
Hip surgery among patients >50 yr of age: mortality rate identical with liberal (hemoglobin <10 g/dL) and restrictive (<8 g/dL) transfusion strategies

Specific risks associated with transfusion
Infection: in developed countries, risk for transmission of viral disease low; bacterial infection in platelets greatest risk; risk can never be completely eliminated (eg, risk from prions); blood banks aggressively searching for ways to inactivate pathogens; risk for viral disease from transfusion high in third-world countries; worldwide, transfusions responsible for almost 10% of HIV infections
Transfusion-related acute lung injury (TRALI): most common fatal reaction to transfusion in United States in 2012; occurs across sexes, ages, and clinical settings; fresh frozen plasma (FFP) slightly overrepresented; syndrome consists of acute respiratory distress occurring within 6 hr of transfusion, severe hypoxemia (<90% O2 saturation on room air), and bilateral infiltrates on chest x-ray in patient with no findings of circulatory overload nor evidence of preexisting lung disease; treatment supportive; cause unknown; occurs in ≤1 in 5000 patients
Morbidity in trauma patients: transfusions often administered because data suggest avoidance of colloid resuscitation, but red blood cell (RBC) transfusion more than doubles risk for adult respiratory distress syndrome (ARDS); necessity of administration must be determined; packed RBCs (PRBCs) associated with increase in mortality risk by factor of 1.5
FFP: among patients in ICU, FFP increases risk for infection (mostly pulmonary); avoid unless specifically indicated
Effects in patients undergoing noncardiac surgery: in study of >10,000 anemic patients, transfusion associated with mortality risk of almost 7%, compared with 4.2% in patients without transfusion; also associated with higher risk for cardiac and pulmonary complications
Massive transfusion protocol: patients sustaining large blood loss (≥50% of blood volume) should receive mixture of RBCs and plasma from outset of treatment; associated with less overall risk than administering PRBCs alone (ratio of FFP to RBCs important; mixture more closely approximates composition of whole blood)
FFP and platelets: several studies show associated risks for TRALI and mortality exceed those with PRBCs
Transfusion guidelines from American Society of Anesthesiologists: provide current standard of care; recommend administering RBCs at hemoglobin ≤6 g/dL, especially when anemia acute; RBCs considered unnecessary when hemoglobin >10 g/dL; coagulopathy — visually inspect surgical field; obtain laboratory evaluation before transfusing plasma; administer platelets to bleeding patients with platelet count ≤50 x 10^9/L; platelet transfusion not indicated when platelet count >100 x 10^9/L; FFP indicated when prothrombin time >1.5 times normal or international normalized ratio ≥2 times

Educational Objectives
The goals of this program are to improve transfusion practices and the management of peripheral nerve injuries related to regional anesthesia. After hearing and assimilating this program, the clinician will be better able to:
1. Follow evidence-based criteria when ordering transfusions.
2. Develop a massive transfusion protocol.
3. Recognize the most common fatal injury associated with transfusions in the United States.
4. Distinguish among the 3 basic types of peripheral nerve injuries.
5. Use electrodiagnostic studies to guide management of postoperative neurologic injuries.

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, the following has been disclosed: Dr. Hardman is on the Speakers’ Bureau of Cadence Pharmaceuticals. Dr. Passannante and the planning committee reported nothing to disclose.
normal, respectively, or when blood loss exceeds one blood volume; FFP often not administered in sufficient quantities (eg, patient weighing 70 kg who loses 30%-40% of blood volume requires >2 U [ie, aliquot routinely administered]; cryoprecipitate — rarely indicated in fibrinogen >150 mg/dL [speaker uses 75 mg/dL as trigger]; if bleeding excessive, consider use of desmopressin or topical hemostatic agents; if above options fail, consider administration of recombinant factor VII

Alternatives to PRBCs: lower transfusion trigger; blood conservation strategies; coagulation factors continually improving; maintain normothermia (decreases need for transfusion, compared to hypothermia); other advances anticipated in near future (eg, process that eliminates need for cross-matching)

Conclusions: many transfusions unnecessary and increase risks; blood supply safer than in past (fears far outweigh actual risks); no effective trigger for RBC transfusion currently exists; clinicians should be more reluctant to transfuse, even if uncomfortable with this practice; TRALI most common fatal reaction to blood transfusion; 8 g/dL safe trigger for most patients; pre-operative anemia increases risk for mortality, but transfusion further increases risk

Nerve Injury After Peripheral Nerve Blockade for Surgery

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Case Scenario: young female athlete with torn rotator cuff and labrum; scheduled for arthroscopic surgery; current standard of anesthesia practice — administer single-injection block and general anesthesia (GA)

Terminology and neuroanatomy: normal peripheral nerve — resembles electric cable; outer surface covered by epineurium, which varies in thickness among individuals; encloses nerve fascicles (bundles of axons and intrinsic blood vessels surrounded by perineurial sheath); nerve also has extensive extrinsic vascular supply under adrenergic control; layer of loose connective tissue (internal epineurium) lies just under epineurium; needles used for anesthesia large compared with size of fascicles (ie, average 25-gauge needle 500 µ in diameter, while fascicles range from 100 to 1000 µ in diameter); longitudinal length of fascicles irregular; nerves sensitive to stretching and changes in torsion; nerve architecture — going from nerve root to terminal branch, connective tissue becomes more tightly organized and protective of nerve; more proximally, continuity seen between interstitial fluid and subarachnoid space

Nerve injury classification

Morphologic classification: neurapraxic — most common type of injury; associated with best prognosis; most resolve quickly and spontaneously; usually associated with mild deficits, but can present as flaccid limb after peripheral nerve block (PNB); axonotomitic — injury to axon as well as Schwann cell; less common than neurapraxic injuries, but slower to resolve; nerve regenerates at rate of 1 mm/day as long as integrity of epineurium intact, but recovery may be incomplete; neurotrophic — most severe; involves transection of nerve; graded according to structures damaged; least common type of injury; requires surgical treatment (does not heal spontaneously); prognosis poor

Mechanisms of injury: rarely involve PNB needles; mechanical trauma — usually associated with surgery, but may be from needle; trauma may be blunt or sharp; stretch and compression — most common mechanism; may result from positioning, tourniquets, mass lesions such as hematomas (may push into nerve), or injection of local anesthetic into nerve bundle; thermal — associated with cautery; ischemic — due to damage to vascular supply, mass effect from hematoma or edema fluid, tourniquets, or epinephrine; chemical — local anesthetics neurotoxic (may induce apoptosis [especially lidocaine]); examples of multiple causality — thermal injury distally and mechanical injury proximally; 2 subclinical injuries combining to cause nerve damage; minor anesthesia-related injury combining with preexisting asymptomatic injury to produce clinical manifestation of nerve damage

“Bad guy” classification: injury may be caused by surgeon, patient’s preexisting disposition (eg, diabetes, vascular disease, genetic predisposition), or anesthesia provider

Risks for injury: risk for severe permanent nerve injury after PNB 1 in 10,000; problems in determining exact incidence of injuries — nerve injury often not primary outcome of studies reporting data; lack of standardized definition of postoperative neurologic symptoms (PONS); varies according to individual who assigns blame (in North America, usually surgeon); French study — among >23,000 PNBs performed in 1997, incidence of nerve injury 2 in 10,000; meta-analysis — >32 studies between 1995 and 2005; epidural and spinal anesthesia associated with similar incidence of permanent and severe injury; injuries associated with femoral, axillary, and interscalene blocks 10 to 100 times more frequent, but most subsequently resolved; study of 7000 PNBs — 30 patients developed severe neurologic complications (3 deemed related to block [incidence 0.04%]); retrospective study (University of Michigan) — >380,000 cases (largest to date); found that patients with diabetes, hypertension, or tobacco use most likely to present with nerve injuries; first study to identify hypertension as risk factor; epidural and general anesthesia most often associated with injuries; risk greatest with neuro-, cardiac, general, and orthopedic surgery; overall incidence of neuropathy 0.03%

Summary of findings: serious, permanent nerve injury after PNB rare (2-4 in 10,000), but temporary minor injury relatively common (3%-16%); no differences in injuries seen between single injections and catheters; non-block-related causes of injury 9 times more common than block-related causes

Factors controlled by anesthesia providers: needle type and size; angle of approach; use of adjuvant medications such as epinephrine; level of sedation; nerve localization techniques; injury less likely with tangential than with perpendicular approach; long beveled needles more likely than short beveled needles to penetrate and injure nerve; paresthesia anger vs nerve stimulation — no difference in PONS; sensitivity and specificity of nerve stimulation not optimal; nerve stimulation vs ultrasonography — in randomized controlled trial, Liu and colleagues observed no differences in PONS between techniques; each movement of needle tip increases risk for injury; difficult to see needle with ultrasound; many transfusions unnecessary and increase risks; pre-operative anemia increases risk for mortality, but transfusion further increases risk

Responding to problems: stay informed and follow up (patients appreciate show of concern); obtain consultation from neurologist; perform electrodagnostic studies (nerve conduction or electromyography [EMG]) within several days of injury; approach to new-onset PONS: distinguish severe from nonsevere; if severe (flaccid paralysis after PNB wears off), rule out treatable cause; whether injury neurapraxic, axonotmetic, or neurotmetic becomes evident over time; impossible to hasten recovery; treat neuropathic pain and provide palliative care

Nerve conduction studies: if patient has complete conduction block, proximal stimulation on day 1 has no effect, but distal stimulation produces compound action potential; persistent
Distal stimulation at day 7 good sign; if nerve transected, distal stimulation produces action potential at day 1, but not day 7, due to progressive deterioration of axon. EMG: can detect abnormal spontaneous muscular activity associated with denervation; increased insertional activity — flurry of spiking activity associated with needle insertion; rapid appearance suggests recent injury; absence suggests less serious injury; other findings — abnormal spontaneous activity suggests preexisting injury; activation of motor units despite paralysis suggests good prognosis (patient likely to recover); frequency of testing — perform initially and repeat at 4 wk; discontinue if patient improving; if no improvement, repeat at 3-mo intervals until patient improves or surgical intervention planned; consider magnetic resonance imaging; studies can confirm existence of abnormality but do not determine etiology.

**Reduction of medicolegal risk:** disclose serious as well as less serious risks to patients; use light sedation whenever possible so patient can alert clinicians to pain or paresthesia; have standardized regional block note to clarify documentation; take focused history before procedure (ask about remote injuries, paresthesias, or dysesthesias); perform quick focused neurologic examination; send patient home with written instructions and 24-hr contact information; call daily and document findings; if patient discharged with catheter, call 24 hr after catheter removal to ensure resolution of block.

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### 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
1. Which of the following statements about preoperative anemia is(are) correct?
   (A) Associated with increased risk for mortality
   (B) Perioperative transfusion improves survival
   (C) Treatment before surgery has little impact on outcomes
   (D) All the above

2. Studies comparing liberal and restrictive transfusion policies for critical care patients have found which of the following?
   (A) Transfusion policies should be more liberal
   (B) Transfusion reduces mortality in patients with hematocrit between 30% and 35%
   (C) Transfusion increases survival among patients undergoing coronary artery bypass surgery
   (D) None of the above

3. In the United States, the most common cause of death related to transfusion is:
   (A) Sepsis
   (B) Hemolytic reaction
   (C) Hepatitis B infection
   (D) Transfusion-related acute lung injury

4. The American Society of Anesthesiologists recommends administration of red blood cells when the patient’s hemoglobin drops below:
   (A) 6 g/dL
   (B) 7 g/dL
   (C) 8 g/dL
   (D) 9 g/dL

5. Current evidence suggests that a safe trigger for whole blood transfusion is a hemoglobin level of:
   (A) 7 g/dL
   (B) 8 g/dL
   (C) 9 g/dL
   (D) 10 g/dL

6. The most common morphologic type of nerve injury is:
   (A) Axonotmetic
   (B) Neurotmetic
   (C) Neurapraxic
   (D) Axonapraxic

7. The risk for severe permanent injury after a peripheral nerve block is:
   (A) 1 in 100
   (B) 1 in 1000
   (C) 1 in 10,000
   (D) 1 in 100,000

8. Which type of anesthesia is least likely to be associated with permanent and severe nerve injuries?
   (A) Spinal
   (B) Epidural
   (C) General
   (D) Interscalene block

9. Nerve injury after peripheral nerve block in a surgical patient is:
   (A) Usually related to the anesthesia
   (B) Most likely the result of causes unrelated to anesthesia
   (C) Equally likely to result from anesthesia-related and unrelated causes

10. Prompt use of electrodiagnostic studies in a patient with postoperative neurologic symptoms can determine the:
   1. Cause of the injury
   2. Severity of the injury
   3. Location of the injury
   (A) 1, 2, 3
   (B) 1, 2
   (C) 1, 3
   (D) 2, 3

Answers to Audio-Digest Anesthesiology Volume 54, Issue 16: 1-C, 2-B, 3-B, 4-D, 5-B, 6-A, 7-D, 8-C, 9-C, 10-D