Postpartum hemorrhage (PPH):

Case example: 27-yr-old gravida 5, para 2, at 27-wk gestation with bleeding and premature rupture of membranes (ROM); good airway on examination; has history of 2 cesarean deliveries and exploratory laparotomy; and of anxiety; no active bleeding, but known anterior placenta previa (magnetic resonance imaging shows acrata, but no percreta); intravenous (IV) access obtained; patient typed and cross-matched for 4 U packed red blood cells (PRBC); obstetric-gynecologic oncology surgeon consulted; patient stable for cesarean delivery, but at high risk for bleeding

Regional anesthesia (RA): not absolutely contraindicated; consider duration of surgery (possibly prolonged due to previous abdominal surgeries) and risk for bleeding; risks — procedure may outlast spinal anesthesia (SA); sympathomimetic undesirable with chance of hypovolemia; may require airway management while focusing on volume status; benefits — less exposure of fetus to volatile agents and medications (long-term effects possible); support person present; however, if bleeding occurs, support person may need escort by staff member (ie, may reduce available help); combined spinal epidural (CSE) — accommodates lengthy surgery; allows improved postoperative pain control; general anesthetic (GA) — benefits include secure airway and allowing focus on hemodynamic stability; risks include fetal exposure to multiple medications and contribution of volatile agents to uterine atony

Anesthetic plan: SA to minimize fetal exposure, with conversion to GA if prolonged procedure needed; obtain preoperative central venous access; patient developed acute bleeding, with nonreassuring fetal heart rate (FHR) tracing; rapid induction of GA with IV access and monitoring established; oxytocin (Pitocin, Syntocinon) infusion administered for bleeding from unanticipated placenta previa and massive transfusion protocol implemented with cell salvage; estimated blood loss (EBL) of ≥3 L replaced with 4 U PRBCs, 2 U fresh frozen plasma (FFP), and 266 mL from cell salvage; patient extubated and transferred to intensive care unit

Postpartum hemorrhage (PPH): ≥500 mL for vaginal delivery and >1 L for cesarian delivery; increasing incidence in United States due to increased uterine atony (most commonly caused by prolonged delivery)

Medical methods of control: oxytocin — may be ineffective after oxytocin induction; dose ≤40 U/L may cause hypertension; methylergonovine (Methergine) — ergot alkaloid; dose 0.4 mg intramuscularly; causes systemic hypertension; carboprost (Hemabate) — prostaglandin F2α analogue; causes systemic and pulmonary vasoconstriction and bronchoconstriction; use with caution in patients with asthma; misoprostol (Cytotec) — historically administered rectally, but recent practice utilizes buccal or sublingual routes; has gastrointestinal side effects

Surgical methods of control: manual evacuation — stop uterine drugs, transfer to operating room, and provide RA or GA (based on hemodynamic status); resume uterine drugs after evacuation; intrauterine compression devices — intrauterine tamponade (with, eg, Bakri balloon, Sengstaken-Blakemore tube); embolization — for stable patient after vaginal delivery; surgeon should remain immediately available; temporary occlusion (2-6 wk) preserves fertility; laparotomy with or without hysterectomy — perform when derangement of vital signs exceeds that expected with EBL (suggesting uterine rupture or internal hemorrhage), or if conservative management unsuccessful; uterine sandwich — compression sutures plus balloon tamponade (imposing internal and external compression)

Cell salvage: theoretic concerns — amniotic fluid embolus, alloimmunization, and heparin contamination; single suction preferred (gave larger volume for reinfusion); minimal risk for alloimmunization seen with 0.8 mL fetal RBC in reinfusion pack (≥9 mL in maternal system after vaginal delivery)

Maternal trauma: leading cause of maternal death in developed countries; occurs in 6% to 7% of pregnancies, with 0.3% to 0.4% admitted to hospital; two-thirds due to motor vehicle accidents and 10% to 30% from falls or physical abuse; risk for serious abdominal injury increased (serious chest or head injuries less likely); most injuries blunt trauma; morbidity and mortality rates similar to those of nonpregnant patients; placental abruption most common cause (42%) of fetal death; fetal demise increases with increasing injury severity score, maternal shock, truncal injury, and vaginal bleeding; increased maternal blood volume may mask hypovolemia; pregnancy may elevate heart rate 10 to 15 bpm and decrease systolic blood pressure by 10 to 15 mm Hg, but hypotensive, tachycardic patient should be treated for hypovolemia; normal respiratory changes include elevated O2 consumption, decreased functional reserve capacity, increased minute ventilation, and pCO2 ≤30 mm Hg; hypovolemia from uterine vasoconstriction may put fetus at risk; administer O2 on arrival to prevent fetal hypoxia and acidosis; hypcapnia and alkalosis can reduce O2 delivery to fetus; maternal analgesia reduces hyperventilation; give early thought to airway management, as massive resuscitation may exacerbate difficult airway

Initial assessment: maternal — follow Advanced Cardiac Life Support guidelines; hypovolemic shock associated with fetal mortality of 80%; fetal monitoring determines viability of pregnancy

Educational Objectives
The goals of this program are to improve the management of obstetric hemorrhagic emergencies and labor analgesia. After hearing and assimilating this program, the clinician will be better able to:

1. Identify and administer the appropriate medical method of control to a patient experiencing postpartum hemorrhage.
2. Implement techniques to optimize uterine blood flow to support preservation of pregnancy.
3. Describe the physiology of labor and the associated pain.
4. Choose the best technique for epidural placement.
5. Prevent complications of neuraxial labor analgesia.

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. In their lectures, Drs. Grondin and Gaiser present information that is related to the off-label or investigational use of a therapy, product, or device.
Secondary survey: assess laboratory values; type and cross; administer immunoglobulin for Rh-negative patient; radiographic studies—should allow for viable fetus; fast examinations have sensitivity of 83% for intraperitoneal fluid in pregnant patient; computed tomography (CT) can lead to neonatal neoplastic effects (use with caution); indications for diagnostic laparotomy—same as for nonpregnant patients

Direct abdominal trauma: causes placental abruption in ≤66% of cases (consider abruption in suddenly unstable anesthetized patient); standard of care dictates continuous FHR monitoring and tocodynamometry; negative predictive value 100% for pain-free patient with normal FHR and tocodynamometer tracing

Reasons for delivery: control hemorrhage, enable exposure of nonobstetric injuries, or for unstable spinal injury; with emergent delivery, infant survival 45% and maternal survival 72%; in cases of maternal cardiac arrest, make decision to deliver within 4 min (may aid maternal resuscitation)

Intraoperative management: secure airway; risks for difficult intubation, aspiration, and hypoxia elevated; perform left uterine displacement to prevent uterine aortocaval compression; use laboratory values to guide product administration

Preservation of pregnancy: optimize uteroplacental blood flow if delivery delayed; maintain blood pressure with vasopressors (eg, ephedrine, phentylephrine); avoid maternal hypovolemia and hypoxia; severe hypercapnia can cause myocardial depression and hypotension in fetus; normothermia beneficial to coagulation status; FHR—can be monitored at ≥18 wk gestation; variability present at 24 to 27 wk; trained personnel should monitor and make decisions; have plan if FHR tracing becomes unstable (delivery vs continued monitoring); discuss case with obstetrician; obtain preoperative FHR to ascertain viability, and establish postoperative FHR and tocodynamometry

Transfusion therapy: based on trauma studies; early initiation of blood components prevents dilutional coagulopathy; hypotensive resuscitation may be attempted, but must be modified based on fetal wellbeing; transfuse using 1:1:1 ratio of PRBCs to FFP to platelets

Recombinant factor VIIa: approved by Food and Drug Administration (FDA) only for hemophilia patients; has potential for thromboembolic complications; expensive (≈$10,000 per dose); its use for maternal bleeding (often, low tissue factor states) described in many case reports; results inconclusive (based on biased studies)

Tranexamic acid: inhibits plasminogen activation and plasmin activity, which prevents clot breakdown; contraindicated in disseminated intravascular coagulation; CRASH-2 study saw reduction in all-cause mortality of 9%, with no increase in vascular occlusive events; also associated with slightly decreased blood loss in normal cesarien deliveries, decreased need for uterotonics, may be used for maternal bleeding (often, low tissue factor states) and for hemorrhage control; cell salvage safe and effective; special needs of pregnant trauma patients include changes in ventilator settings, left uterine displacement, and possible fetal monitoring or delivery

Conclusions: treat stable patients like other obstetric patients, but have backup plan in place and maintain extra precautions (eg, large bore IV); treat unstable patients like trauma patients (utilize surgical and medical methods of hemorrhage control); cell saline safe and effective; special needs of pregnant trauma patients include changes in ventilator settings, left uterine displacement, and possible fetal monitoring or delivery

Analgesia During Labor

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Definition of labor: pathophysiologic process in which sufficiently frequent, strong uterine contractions cause thinning and dilation of cervix, permitting passage of fetus from uterus through birth canal; 2 components of labor (cervical dilation and uterine contraction) account for sensation; original Friedman labor curve represented period of minimal cervical dilation followed by rapid cervical dilation; currently, onset of contractions to cervical dilation considered stage 1, and complete cervical dilation to delivery of baby considered stage 2; original curve developed when most parturients ≤70 kg and without epidurals (1950s), and does not apply to current patients; modern curve shows more linear progression through first stage of labor; with epidural, duration of stage 1 ≤4 hr (stage 2 = 1 hr)

First stage of labor: visceral pain, primarily result of dilation of cervix, with small component from mechanical receptors; nerves pass through paracervical region and synapse in lamina 5 of dorsal horn; cutaneous fibers from T10 to L1 also synapse in lamina 5 of dorsal horn; pain referred to T10 to L1 distribution (nonspecific sensation)

Second stage of labor: somatic pain occurs as baby descends through birth canal, causing stretching of fascia, skin, subcutaneous tissue, and other somatic structures; localized pain in perineum caused by pudendal nerve (synapses at S2-S4); anesthetic plan must address T10 to L1 (stage 1) and S2 to S4 (stage 2)

Chronic pain after delivery: chronic postsurgical pain known entity (after, eg, breast surgery, thoracotomy, inguinal hernia); cohort study reveals 10% of women complain of acute pain 36 hr postdelivery; ≤10% of women also report pain 8 wk postpartum; patients become hypersensitized during immediate postpartum period; prevention of acute postpartum pain theorized to decrease chronic pain associated with vaginal delivery

Informed consent: courts uphold maternal consent during labor; birth plan not informed consent, and active experience of labor may influence decisions

Techniques for epidural placement: ultrasonography—complicated, with prolonged learning curve; not often used; study found distance from skin to epidural space decreased in Asian population, compared with black population (accidental dural puncture more common in Asian patients)

Loss of resistance to air vs saline: 50% of providers use air and 50% use saline; no difference found in incidence of accidental dural puncture; risk for postdural puncture headache (PDPH) markedly higher in air group vs saline group; PDPH caused by air in intrathecal space (has rapid onset); technique during study used full 5 mL of air; technique safe if least amount of air possible used (ie, syringe not emptied); meta-analysis shows no difference in outcome, number of attempts, paresthesias, or accidental dural puncture; injection of saline (3-5 mL) into epidural space before introducing catheter decreases probability of cannulation of epidural vein

Input from patient: among morbidly obese patients, often helpful in identifying midline

Sleep deprivation: study reveals no difference in time to placement, number of attempts, or complications when comparing providers at beginning or end of 24-hr shifts; more providers harmed by 24-hr call than patients

Infectious complications: epidural abscess—incidence high following neuraxial anesthesia in obstetric population; collection of pus in epidural space compressing spinal cord; incidence 1 in 200,000; more common in immunocompromised patients; most common organisms Staphylococcus aureus and Staphylococcus epidermidis (skin flora); meningitis—presents with headache 8 hr to 8 days after dural puncture (similar to PDPH); aggressive approach indicated if fever present; generally occurs in healthy people; causative agent α-hemolytic streptococci (respiratory organism); mask should be worn during epidural placement and changed between patients (case of maternal death from meningitis documented in which organism cultured from respiratory tract of anesthesiologist)

Preparation of skin: chlorhexidine not approved by FDA; culture positive 1 in 3 times after iodine preparation (air dried), but only 1 in 10 times after chlorhexidine preparation; adding alcohol yields even better results; FDA approval withheld because chlorhexidine causes irreversible conduction
of phrenic nerve in rats, and documentation of one case of aseptic meningitis

**Labor analgesia: guidelines** — goal of least amount of motor block possible (decreases risk for operative vaginal delivery); multiple infuses available; Cochrane review confirms epidural results in improved pain relief, reduced neonatal acidosis, increased incidence of assisted vaginal delivery (due to motor block), and higher incidence of hypotension, compared with no epidural

Patient-controlled epidural analgesia (PCEA): associated with fewer interventions and less local anesthetic use, compared with continuous infusion; pain with pushing slightly higher with PCEA, but no difference in satisfaction rates reported

Automated bolus: study randomized patients to 2.5 mL every 15 min, 5 mL every 30 min, or 10 mL every 60 min, with same infusate; patients receiving 10 mL bolus most comfortable; larger bolus produces increased spread in epidural space, with improved sacral anesthesia; speaker now uses low continuous rate (5-6 mL/hr), with 8 mL bolus every 20 min or 10 mL bolus every 30 min

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| 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 |
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ANESTHETIC CARE OF THE OBSTETRIC PATIENT

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1. Choose the correct statement about the use of regional anesthesia when postpartum hemorrhage (PPH) is expected.
   (A) Awake patient eliminates concern for airway management
   (B) Anesthesiologist is free to focus on fluid status
   (C) It is absolutely contraindicated
   (D) Associated sympathectomy undesirable when there is risk for hypovolemia

2. PPH is defined as blood loss _______ for vaginal delivery and _______ for caesarian delivery.
   (A) ≥300 mL; ≥500 mL
   (B) ≥500 mL; ≥500 mL
   (C) ≥500 mL; >1 L
   (D) >1 L; > 1.5L

3. Which of the following medications should be used with caution in a patient with asthma?
   (A) Oxytocin
   (B) Methylergonovine
   (C) Carboprost
   (D) Misoprostol

4. What is the most common type of traumatic injury sustained during pregnancy?
   (A) Chest
   (B) Abdominal
   (C) Head
   (D) Orthopedic

5. Reasons for fetal delivery after maternal trauma include all the following, except:
   (A) Control of hemorrhage
   (B) Exposure of nonobstetric injuries
   (C) Unstable spinal fracture
   (D) Pulmonary contusion

6. Select the correct statement about the definition of labor.
   (A) There are 2 components
   (B) Stage 2 typically lasts for 4 hr
   (C) The modern curve has a parabolic progression through the first stage of labor
   (D) Progression of labor has remained unchanged despite the advent of modern analgesic practices

7. Pain experienced by the mother during the first stage of labor is best characterized as:
   (A) Somatic
   (B) Neuropathic
   (C) Visceral
   (D) None of the above

8. Studies comparing use of loss of resistance to air vs saline during epidural placement found which of the following?
   (A) Higher incidence of headache associated with saline
   (B) Similar rates of unanticipated dural puncture
   (C) Injecting saline into the epidural space increases the chance of venous cannulation
   (D) More paresthesias with the use of air

9. The primary goal of obstetric analgesia is to:
   (A) Minimize motor block as much as possible
   (B) Use the lowest amount of local anesthetic possible
   (C) Provide complete analgesia
   (D) Prevent hypotension

10. Automated epidural boluses are most effective during labor when administered at high (8-10 mL) doses over long (20-60-min) intervals.
    (A) True
    (B) False

Answers to Audio-Digest Anesthesiology Volume 55, Issue 11: 1-C, 2-D, 3-B, 4-A, 5-D, 6-B, 7-C, 8-A, 9-A, 10-C