Chapter

14 CHOICE OF ANESTHESIA TECHNIQUE

Elizabeth L. Whitlock

TYPES OF ANESTHESIA

1. What are the three major categories of anesthetic technique?
2. What four components are part of the clinically accepted definition of general anesthesia?
3. What are the four levels on the continuum of sedation, as defined by the American Society of Anesthesiologists? Describe them in terms of patient responsiveness, ability to maintain a patent airway and spontaneous ventilation, and ability to maintain cardiovascular homeostasis.
4. Which of the four levels on the sedation continuum might an anesthesia provider encounter during monitored anesthesia care?

CHOOSING AN APPROPRIATE ANESTHETIC TECHNIQUE

5. What major factors go into the choice of anesthetic technique?
6. What are some perioperative roles of peripheral nerve blockade and neuraxial anesthesia besides surgical analgesia?
7. How is "preventive analgesia" defined?

PRACTICAL ASPECTS OF ANESTHESIA CHOICE

8. What is preoxygenation? Why is it performed prior to anesthesia induction?
9. By what drug administration routes may induction of general anesthesia occur?
10. What is the most common high-potency volatile anesthetic gas used for inhaled induction of anesthesia, and why?
11. When is a rapid sequence induction (RSI) technique used? What differentiates an RSI from a standard intravenous induction?
12. Why is mask ventilation not performed in a true RSI? What defines a modified RSI?
13. How is cricoid pressure achieved? How efficacious is cricoid pressure?
14. What airway management technique is considered safest in a cooperative patient at high risk for difficult or impossible intubation?
15. What technique is used to achieve endotracheal intubation in a patient at risk for both aspiration of gastric contents and difficult or impossible intubation?
16. What advantages do potent volatile anesthetics offer as a maintenance drug?
17. What are the drawbacks of potent volatile anesthetics?
18. What differentiates nitrous oxide from the potent volatile anesthetics?
19. What are the advantages and disadvantages of propofol as an anesthetic maintenance drug, compared with potent volatile anesthetics?
20. Name some procedural and patient requirements for successful regional anesthesia as the sole anesthetic technique.
21. Why might regional or neuraxial anesthesia be particularly desirable for patients with severe systemic disease?
22. What are some options available to the anesthesiologist in the event that a peripheral nerve block is attempted but surgical anesthesia is not accomplished?

23. List some pharmacologic and nonpharmacologic methods of providing sedation and anxiolysis during monitored anesthesia care (MAC).
24. What are common manifestations of respiratory depression from oversedation?

ENVIRONMENTAL IMPACT

25. What is the atmospheric impact of potent volatile anesthetics and nitrous oxide?
26. What are techniques to minimize the environmental impact of inhaled anesthetics?

ANSWERS*

TYPES OF ANESTHESIA

1. Anesthetic technique is often grouped into three major categories: general anesthesia, regional anesthesia, and monitored anesthesia care (MAC). A surgical procedure (e.g., extremity surgery) may be amenable to more than one type of anesthesia. (213)
2. The four components of general anesthesia include immobility, amnesia, analgesia, and patient lack of harm. The concept of lack of harm was developed because of the potentially dangerous effects of general anesthetics, such as respiratory depression and hypotension. The modern approach to general anesthesia involves administration of several medications, often targeted to a specific component of general anesthesia (e.g., fentanyl for analgesia). (213)
3. The American Society of Anesthesiologists (ASA) defines the following four levels on the continuum of sedation:
   Minimal sedation: A patient responds briskly to verbal stimulus, and airway and cardiovascular function are unaffected.
   Moderate sedation: A patient responds purposefully to verbal or tactile stimuli, and airway and cardiovascular function are usually maintained.
   Deep sedation: Repeated or painful stimulus is required for the patient to respond. Spontaneous ventilation may be inadequate, and airway intervention may be required. Cardiovascular function is usually maintained.
   General anesthesia: The hallmark of general anesthesia is absence of patient responsiveness, even with a painful stimulus. Airway intervention is typically required, as spontaneous ventilation is usually inadequate. Cardiovascular homeostasis may be impaired by the medications required to induce general anesthesia. (214)
4. When caring for a patient receiving MAC, an anesthesia provider must be prepared for all degrees of sedation, from minimal sedation to an "unplanned" general anesthetic if the surgical procedure cannot be accomplished safely with sedation. The appropriate medications and airway equipment for general anesthesia should be available for a patient receiving MAC. (214)

CHOOSING AN APPROPRIATE ANESTHETIC TECHNIQUE

5. The anesthesia provider must weigh several factors when deciding anesthetic technique, including the demands of the type of surgical procedure, the patient's coexisting diseases, and patient preferences. Reconciling the requirements and risks inherent to the surgical procedure and pathology it is intended to treat (e.g., acute appendicitis, presenting for laparoscopic appendectomy) with the patient in whom the disease occurs (e.g., a 5-year-old with no current intravenous access) and designing a safe and effective anesthetic plan is one of the most important challenges for the anesthesia professional. (214)
6. Peripheral nerve blockade or neuraxial anesthesia may be used in combination with general anesthesia to provide postoperative analgesia, reduce rates of postoperative chronic pain, and perhaps even reduce intraoperative blood loss.

*Numbers in parentheses refer to pages, figures, boxes, or tables in Pardo MC, Miller RD, eds. *Basics of Anesthesia*. 7th ed. Philadelphia: Elsevier; 2018.

For example, consider the development of "enhanced recovery after surgery" care pathways (e.g., for elective laparoscopic bowel resection), which emphasize the use of partial neuraxial analgesia via an epidural catheter both intraoperatively and postoperatively. In this situation an epidural catheter may be used despite the requirement for deep neuromuscular blockade and controlled ventilation to facilitate laparoscopic surgery, which necessitates general anesthesia during the surgical procedure itself. (215)

7. Preventive analgesia is defined as analgesia lasting longer than 5.5 half-lives of an analgesic drug. (215)

PRACTICAL ASPECTS OF ANESTHESIA CHOICE

8. Performed prior to induction of anesthesia for a general anesthetic, preoxygenation—also called denitrogenation—is the replacement of nitrogen in the patient's functional residual capacity by the inhalation of 100% oxygen by face mask. Adequate preoxygenation can reduce or eliminate hypoxemia occurring between induction of anesthesia and institution of controlled ventilation. It does this by providing a reservoir of oxygen in the lungs, which is gradually absorbed even during periods of apnea. There are two regimens that typically achieve replacement of 80% of the functional residual capacity with oxygen:
   - Allow the patient to take eight vital capacity breaths of 100% oxygen over 60 seconds.
   - Allow normal tidal breathing of 100% oxygen for 3 minutes. (216)
9. Induction of anesthesia may be accomplished by an inhaled technique using volatile anesthetic gases or by an intravenous technique. In some cases, both techniques are used simultaneously. For example, a common method of inducing anesthesia in a pediatric patient is to perform an inhaled induction with the goal of immobility (deep sedation or general anesthesia) while an intravenous line is placed; then, to ensure adequate depth of anesthesia for intubation, an additional dose of intravenous hypnotic (e.g., propofol) is given prior to instrumenting the airway. (216)
10. For inhaled anesthesia induction, sevoflurane is most commonly used because of its high potency, low pungency, and relatively low lipid solubility, resulting in desirable rapidity of onset. Desflurane is very pungent and causes airway irritability manifested as coughing, bronchospasm, or laryngospasm; it is poorly tolerated as an agent for inhaled induction. Isoflurane is less pungent than desflurane, but because of its high lipid solubility it cannot be used to induce general anesthesia rapidly as a sole agent. (216)
11. Rapid sequence induction (RSI) is used for patients at risk for aspiration of gastric contents. This group includes patients with a known full stomach, an unknown fasting time, clinically significant gastroesophageal reflux disease, or delayed gastric emptying. The goal of RSI is to minimize the time between onset of unconsciousness and tracheal intubation. The hallmark of RSI is the administration of a rapid-onset neuromuscular blocking drug in "rapid sequence" with a hypnotic of choice. After preoxygenation, an intubating dose of a hypnotic is administered, followed immediately by an intubating dose of neuromuscular blocking drug. Tracheal intubation occurs as soon as intubating conditions are achieved, without the use of mask ventilation. If cricoid pressure is used, it is applied immediately upon loss of responsiveness and only released upon confirmation of correct endotracheal tube placement. (217)
12. During RSI, mask ventilation is generally avoided because it can result in gastric insufflation, increasing the risk of aspiration of gastric contents. In a "modified" RSI, gentle positive-pressure ventilation using pressures less than 20 cm H_2O may be judiciously attempted. Theoretically, low-pressure positive-pressure ventilation reduces the risk of gastric insufflation compared with standard mask ventilation and may be used to reduce the risk of hypoxemia prior to tracheal intubation. (217)
13. Cricoid pressure is achieved by applying a force of 30 newtons (about 7 pounds) of pressure on the cricoid cartilage. This is thought to occlude the esophagus

beneath and decrease the risk of the aspiration of gastric contents. Although the application of cricoid pressure for RSI has been the standard of care for decades, a recent meta-analysis did not demonstrate that its use has had a measurable impact on clinical outcomes during RSI. (217)

14. Awake fiberoptic intubation is typically performed for patients at high risk of a "cannot intubate, cannot ventilate" situation. The hallmark of this technique is the maintenance of consciousness, and therefore a patent airway with adequate spontaneous ventilation, until endotracheal tube placement is confirmed. Induction hypnotics are administered until after endotracheal intubation. (217)
15. Awake fiberoptic intubation may be selected for a patient at high risk for both aspiration and difficult or impossible intubation. The RSI technique relies on rapid endotracheal intubation to avoid hypoxemia, which may progress to cardiac arrest if assisted ventilation cannot be provided. Thus, an awake fiberoptic endotracheal intubation may be performed to (1) maintain a patient's conscious ability to clear regurgitated gastric contents away from the lungs and (2) maintain a patent airway and spontaneous ventilation until endotracheal tube placement is confirmed. (217)
16. Potent volatile anesthetics have several advantages for maintenance of anesthesia. They are easy to titrate, suppress the autonomic response to noxious stimulation, and provide a modest degree of muscle relaxation at clinically relevant doses, which can facilitate surgical exposure. Monitoring the end-tidal anesthetic gas concentration provides a surrogate measure for depth of hypnosis, which is as effective at preventing intraoperative awareness as purpose-built processed electroencephalogram monitors. (217)
17. There are drawbacks to the potent volatile anesthetics for anesthesia maintenance. They increase the risk for nausea and vomiting. Emergence from anesthesia is associated with a paradoxical hyperreactivity state, which can clinically be manifested as airway hyperreactivity (bronchospasm, laryngospasm) and coughing. Volatile anesthetics also depress cardiac contractility and cause peripheral vasodilation, which may be manifested as clinically significant hypotension. (217)
18. There are key differences between nitrous oxide and the potent volatile anesthetics. Nitrous oxide provides relatively less vasodilation and cardiac depression than potent volatile anesthetics. It also has analgesic properties, and due to its low blood solubility also has rapid onset and offset. However, the minimum alveolar concentration required to suppress movement to a painful stimulus is greater than can be delivered at atmospheric pressure, so it cannot be used as a sole agent to ensure hypnosis. (217)
19. Propofol has distinct advantages and disadvantages compared to volatile anesthetics. Propofol reduces postoperative nausea and vomiting rates, and emergence is associated with less coughing and laryngospasm risk. Delivery does not rely on controlled ventilation, so it may be more favorable for open-airway procedures (e.g., bronchoscopy, laryngeal surgery with intraoperative jet ventilation). Propofol does not suppress somatosensory and motor evoked potential signals as severely as volatile anesthetics and thus may facilitate intraoperative neurologic monitoring. However, propofol requires a reliable site of intravenous administration, there is no clinically available way to measure serum propofol concentrations, and the drug may be associated with higher rates of intraoperative awareness due to inadvertent interruption of intravenous administration. Depth of hypnosis monitoring using electroencephalography or auditory evoked potentials may protect against intraoperative awareness, particularly if neuromuscular blockade is concurrently used. (217)
20. In order to provide successful regional anesthesia, there are important procedural and patient requirements to consider, including the following:
    Procedural: The location of the procedure must be amenable to regional anesthesia; for example, the distal extremities in the case of peripheral nerve block or the lower trunk and legs in the case of neuraxial anesthesia. Systemic neuromuscular blockade and controlled ventilation must not be required.

Patient: A cooperative patient who provides informed consent for any planned interventions is required for successful regional anesthesia. (218)

21. For a patient with severe systemic disease, there are unique aspects of regional anesthesia techniques that may be of benefit for the patient. Surgical anesthesia can theoretically be achieved without systemic sedation, assuming appropriate procedure selection. This avoids potential complications of deep sedation and general anesthesia including cardiac depression in patients with marginal cardiac function, difficult or impossible liberation from controlled ventilation in patients with severe underlying lung disease, or unpredictable or undesirable pharmacokinetic effects of organ failure (renal, hepatic) by systemic medications. (218)
22. If surgical anesthesia is not achieved with a peripheral nerve block, either because it was difficult or the resultant block inadequate, several options are available to the anesthesiologist depending on the clinical situation. The block can be supplemented with local anesthetic infiltration, intravenous analgesics and/or sedatives can be administered, surgery can be postponed and the block reattempted at a later time, or general anesthesia can be administered. (218)
23. Although many think first of medications as the means of providing sedation and anxiolysis during monitored anesthetic care, nonpharmacologic methods also have an important role in ensuring patient safety and comfort. Commonly used pharmacologic options include propofol, opioids, and hypnotic medications (most commonly benzodiazepines). Potential nonpharmacologic methods include video or audio distraction and verbal reassurance. Nonpharmacologic methods avoid undesirable side effects (e.g., respiratory depression, paradoxical agitation, or a duration of action longer than required for the procedure). These methods may provide sufficient comfort for well-selected patients who wish to avoid medications. (218)
24. Respiratory depression is common with deep sedation. The respiratory effects of oversedation may be manifested as upper airway obstruction (snoring, obstructive apnea), hypoventilation, and hypoxemia. These risks require that the anesthesia provider be prepared to assist or take over ventilation as the clinical situation indicates. Sedatives that are less likely to cause hypoventilation include ketamine and dexmedetomidine, but these drugs have other side effects and may have synergistic sedative effects with other hypnotic medications. (218)

ENVIRONMENTAL IMPACT

25. Waste anesthetic gases are typically scavenged by a suction mechanism from the operating room to limit occupational exposure for operating room personnel; however, scavenged gas is often vented outside the facility, into the environment. Potent volatile anesthetics and nitrous oxide are ozone-depleting greenhouse gases. Although the global warming potential by volume is greatest for desflurane, nitrous oxide is the most important inhaled anesthetic cause of atmospheric harm because it is used in relatively high concentrations (e.g., 50% to 70% by volume). (219)
26. Environmental impact is minimized by using the lowest total amount of inhaled anesthetic, either by eliminating its use entirely (and providing anesthetic maintenance using total intravenous anesthesia) or by reducing fresh gas flow in the context of low-flow or closed-circuit anesthesia. Choosing the lowest impact volatile anesthetic gas—sevoflurane or isoflurane, depending on acceptable fresh gas flow rates, and avoiding nitrous oxide—also minimizes impact. There exist collection systems for waste (scavenged) gases that are intended to capture anesthetic gases prior to atmospheric release and then potentially reprocess them for human reuse; however, none is yet widely used. As nitrous oxide (from all sources, including anesthetic) is likely to be the most significant ozone-depleting emission for the 21st century, the selection of an anesthetic regimen that takes environmental impact into account—while adding an extra layer of complexity to the choice of anesthetic technique—provides a sophisticated acknowledgment by the anesthesia provider that, as professionals, we have a duty not just to the patient before us but to future patients as well. (219)