National Certification Examination (NCE) Professional Practice Analysis (PPA)

Executive Summary

Published August 2022

The National Board of Certification and Recertification for Nurse Anesthetists (NBCRNA) is an autonomous body, with multidisciplinary and public representation, that is responsible for specifying the requirements for earning and maintaining the Certified Registered Nurse Anesthetist credential. In 2022, the NBCRNA conducted a national **professional practice analysis** (PPA) study of the knowledge, skills, and abilities required for entry-level practice as a nurse anesthetist.

The purpose of the practice analysis is to maintain a logical, practice-related, and research-based content framework for the NCE. NBCRNA conducted this practice analysis study in order to validate a framework for content development of the NCE, to establish a linkage between the NCE test specifications and actual role requirements of the entry-level nurse anesthetist, and to allow the community of nurse anesthetists to provide input into the design of the NCE.

In a key step central to this effort, NBCRNA appointed a PPA Panel that provided leadership and oversight for the project. NBCRNA convened a group of 14 subject-matter experts (SMEs, see Appendix A) in nurse anesthesia, who were representative of the profession with respect to geography (from across the United States) and practice setting, among other demographic variables, and primarily reflective of those nurse anesthetists who are entering the profession. The group was charged with analyzing the practice of nurse anesthesia at entry level and updating the content outline. The following is a summary of the changes made to the content outline:

- Domain I. Basic Sciences – Anatomy and Physiology was separated from Pathophysiology to permit better subcategorization of nonpathologic anatomy and physiology; subcategories of Pharmacology were reorganized and updated. The subdomain of Applied Chemistry, Biochemistry, and Physics was changed to Applied Chemistry, Biochemistry, Physics, and Mathematics, with a subcategory specifically for anesthesia-related math.
- Domain II. Equipment, Instrumentation, and Technology – Airway Equipment category was updated, with the addition of bronchial blockers and the removal of some equipment considered

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obsolete, such as the Combitube and lighted stylet. Transesophageal Echocardiography was added as a subtopic of Cardiovascular monitoring equipment, and Patient Warming Equipment was broken off as its own subdomain. Infusion devices was added as a new subdomain.

- Domain III. General Principles of Anesthesia – Ethical Considerations, Legal Issues, and Safety and Wellness categories were expanded and subdivided. Under Fluid Volume Assessment and Management, subtopics were added for Goal-Directed Fluid Management, Massive Transfusion Protocol, and Thromboelastography. The subtopic for Intraoperative Monitoring was removed as already covered under domain 2. Under Airway Management, retrograde intubation was removed and a topic for Emergency Front-of-Neck Access added. Subdomains for Total Intravenous Anesthesia, Infection Control, and Intraoperative Fire Safety were added.
- Domain IV. Anesthesia for Surgical Procedures and Special Populations – a subcategory for Cardiac Anesthesia including coronary artery bypass, minimally invasive procedures, and management of cardiac devices was added under Surgical and Diagnostic Anesthesia. This replaced a subcategory for Diagnostic/Therapeutic that comprised mostly cardiologic topics. The remainder of those diagnostic/therapeutic topics were reclassified as Non-OR Anesthesia. Some rare neuroskeletal subtopics were also removed from under Surgical and Diagnostic and replaced with an Other subtopic, and a category for Robotic/Laparoscopic Surgery was added; topics were added for Intauterine Surgeries, Postpartum Hemorrhage, Substance Use Disorder Population, and Immune-Compromised Patients.

The practice analysis study consisted of the following five major phases (Figure 1).

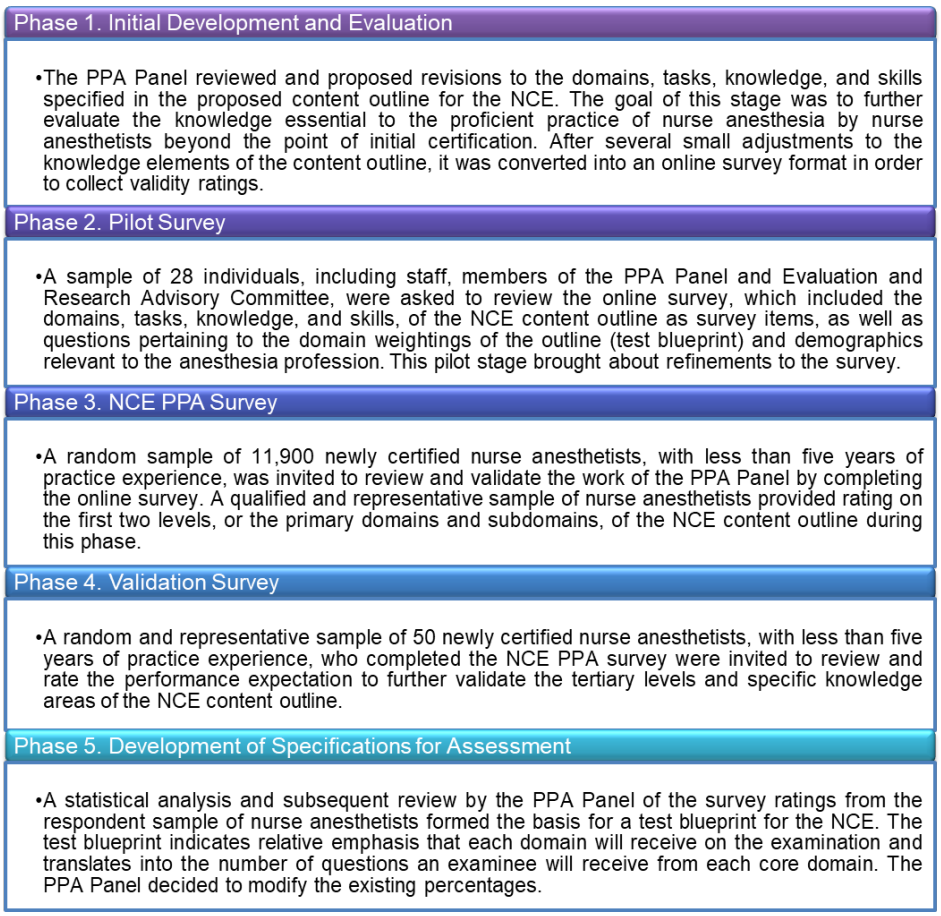

Figure 1. The NCE PPA Study Five Phase Development Process

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Respondents were asked to evaluate each knowledge element in the content outline, rating them using 5-point scales for criticality and frequency, as well as whether the knowledge element was required of a nurse anesthetist using a 3-point scale to measure performance expectation:

- Criticality was defined as the degree that inability to perform duties related to each knowledge element could be seen as causing harm to stakeholders.
- Frequency was defined as how often the nurse anesthetist performs duties that require proficiency in each of the knowledge elements.
- Performance expectation was defined according to the point in the career at which the newly certified nurse anesthetist is first expected to perform duties that require proficiency in the domain or topic

A sample (N = 11,900) of nurse anesthetists within their first five years of initial certification was asked to participate in the primary survey component of the project. From the sample, 1,008 respondents (~9% response rate) completed the primary survey. Another sample (N = 50) was randomly selected out of the 348 respondents who indicated willingness to complete the validation survey. Thirty-one respondents (62% response rate) completed the validation survey. Responses to items in the demographic portion of the survey support the conclusion that participants constituted a reasonable sample of certificants across a variety of practice settings. Respondent data provided strong evidence of validity for the four domains of the content outline (Tables 1 and 2), as well as for nearly all knowledge statements included in the content outline.

Table 1. Summary of Primary Domain Criticality Ratings

Domains	Min	Max	Mean	SD	Variance	Count
I. Basic Sciences	1.00	5.00	3.04	1.32	1.75	1024
II. Equipment, Instrumentation and Technology	1.00	5.00	3.39	1.34	1.80	1024
III. General Principles of Anesthesia	1.00	5.00	3.72	1.41	2.00	1024
IV. Anesthesia for Surgical Procedures and Special Populations	1.00	5.00	3.66	1.36	1.86	1024

Table 2. Summary of Primary Domain Frequency Ratings

Domains	Min	Max	Mean	SD	Variance	Count
I. Basic Sciences	1.00	5.00	4.01	1.28	1.65	1024
II. Equipment, Instrumentation and Technology	1.00	5.00	4.28	1.18	1.39	1024
III. General Principles of Anesthesia	1.00	5.00	4.41	1.13	1.29	1024
IV. Anesthesia for Surgical Procedures and Special Populations	1.00	5.00	4.19	1.16	1.34	1024

While space in this executive summary does not permit reporting these indices for every element of the

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outline, similar summaries of survey ratings were evaluated by the NCE PPA Panel for every knowledge statement on the survey. A total of 17 areas required further review and validation:

- Eight subdomain areas with a mean rating for criticality and/or frequency scales lower than a 3 (moderate endorsement).
- Nine tertiary levels with fewer than 50% of respondents selecting “within the first six months of certification” for the performance expectation scale.

On June 17 the NCE PPA Panel met during a half-day virtual meeting to review the results of the PPA survey and to make recommendations for the NCE content outline. The meeting was devoted to reviewing summaries of ratings of the survey respondents, making decisions about what knowledge statements marked for further review and validation should be included/excluded in the NCE content outline, and recommending any changes to the current domain weights.

Based on the ensuing discussion, and the generally high levels of endorsement on almost all elements of the NCE content outline, minor adjustments to the outline were recommended as a result of the survey analysis and subsequent review:

- In response to survey data indicating that the mathematics element of subdomain I.D., Applied chemistry, biochemistry, physics and mathematics, might merit its own subdomain, the panel split mathematics into a knowledge statement under general principles of pharmacology titled “Pharmacology-related mathematics” and another titled “Nonpharmacology-related mathematics” under subdomain I.D.
- Responding to data regarding clinical relevance of the Chemotherapeutics knowledge statement under Pharmacology, the panel removed the statement and changed a statement under Anesthesia for special populations to Immune-compromised *and oncology* patients.
- In light of input from >38% of validation survey respondents that Precordial Doppler was not used at all, the panel removed that knowledge statement.
- Since III.H.5., Emergency front-of-neck access, is included in the difficult airway algorithm, the panel added “(difficult airway algorithm)” as clarification to the preceding knowledge statement, Difficult airway management, and deleted III.H.5.
- Responding to low criticality ratings on subdomain III.M., Pain theory, the panel combined it with III.L., Pain management, relabeling that subdomain as “Pain,” with reorganized tertiary topics of Pain theory and Pain management.
- The panel removed IV.B.1.a.iv., Intrauterine surgeries, which >32% of validation survey respondents said was not used at all, agreeing that it was too specialized.

The panel proposed to change the domain weights after looking at a few different methods to calculate the domain percentages for the NCE content outline, including the percentage for each domain calculated by taking the average of domain weight allocations indicated by respondents on the survey (Table 3).

Table 3. Proposed Domain Weights

Domains	Current Weights	Survey Respondent Weights	Proposed Panel Weights

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I. Basic sciences	25%	18%	**20%**
II. Equipment, instrumentation, and technology	15%	21%	**20%**
III. General principles of anesthesia	30%	35%	**35%**
IV. Anesthesia for surgical procedures and special populations	30%	26%	**25%**

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Appendix A: 2022 NCE PPA Panel Members

Name	AGE	GENDER	DATE CERTIFIED	PRACTICE YRS	NAEP HDA	CITY	STATE	REGION
1. Anne M Sauri	44	Female	1/26/2006	16	MS Nursing Major	Naperville	IL	REGION 3
2. Cindy Leigh Linenthal	35	Female	12/19/2016	5	MS Nurse Anesthesia/ Anesthesiology	Wirtz	VA	REGION 2
3. Dawn E Bent	53	Female	12/30/2004	17	MS Nursing Major	Philadelphia	PA	REGION 6
4. Dawn R Johnson	54	Female	01/28/2019	3	MS Nurse Anesthesia/Anesthesiology	Suisun City	CA	REGION 5
5. Dennis James	33	Male	5/20/2019	2	DNP	Sugar Land	TX	REGION 7
6. Francesco Salvatore Cardella	34	Male	6/12/2017	4	DNP	Chicago	IL	REGION 3
7. Gloria Chan	36	Female	1/18/2017	5	MS Nursing Major	Brooklyn	NY	REGION 1
8. Katie Cole	38	Female	1/5/2012	10	MS Anesthesia	Lilburn	GA	REGION 2
9. Kelly C Lannert	36	Female	11/10/2017	4	DNP	Chicago	IL	REGION 3
10. Marian Feil	65	Female	1/11/1991	31	-	Abington	PA	REGION 6
11. Rhea Temmermand	35	Female	7/25/2014	7	MS Nursing Major	Evans	GA	REGION 2
12. Sasha Wallace	35	Female	2/6/2019	3	MS Nursing Major	Cleveland Heights	OH	REGION 6
13. Shanah Antoinette Atkinson	32	Female	1/3/2017	5	MS Nursing Major	Charlotte	NC	REGION 2
14. Susan Elczyna	60	Female	11/22/2000	21	MS Nursing Major	Hanover Township	PA	REGION 6
Counts/Avg	~42	Females = 12 (~86%) Males = 2 (~14%)		~10	MSN/MSA = 10 (~72%) DNP = 3 (~21%) Missing = 1 (~7%)			R1 = 1 (~7%) R2 = 4 (~29%) R3 = 3 (~21%) R5 = 1 (~7%) R6 = 4 (~29%) R7 = 1 (~7%)

Appendix B: 2022 DRAFT NCE/SEE Content Outline

I. Basic Sciences (20%)

A. Anatomy and physiology

1. Cardiovascular
2. Respiratory
3. Central nervous system
4. Musculoskeletal
5. Endocrine
6. Hepatic and renal
7. Hematologic
8. Gastrointestinal
9. Immune

B. Pathophysiology

1. Cardiovascular
   a. Ischemic heart disease
   b. Valvular heart disease
   c. Congenital heart defects
   d. Cardiac conduction and rhythm abnormalities
   e. Cardiovascular and peripheral vascular abnormalities
   f. Infectious diseases
   g. Pericardial diseases
   h. Cardiomyopathy and heart failure
2. Respiratory
   a. Obstructive diseases
   b. Restrictive diseases
   c. Infectious diseases
   d. Pulmonary vascular abnormalities
   e. Altered airway anatomy
3. Central nervous system
   a. Neurodegenerative diseases
   b. Myelin diseases
   c. Cerebrovascular diseases
   d. Neuropathies
   e. Psychiatric disorders
   f. Spinal cord disorders

g. Intracranial tumor
h. Congenital abnormalities (e.g., cerebral palsy)
i. Seizure disorders
j. Intracranial hypertension
k. Thermoregulation

4. Musculoskeletal
   a. Myopathies/metabolic abnormalities (e.g., malignant hyperthermia)
   b. Neuromuscular diseases
   c. Skeletal diseases
   d. Musculoskeletal disorders (genetic and acquired)
5. Endocrine
   a. Thyroid and parathyroid disorders
   b. Pituitary disorders
   c. Adrenal disorders
   d. Pancreatic disorders (endocrine disorders)
   e. Other endocrine disorders (thymus-, hypothalamus-, androgen-, and metabolic-related disorders)
6. Hepatic
   a. Infectious diseases
   b. Biliary tract and bilirubin disorders
   c. Cirrhotic disorders
   d. Hepatovascular abnormalities
7. Renal
   a. Intrinsic kidney disorders
   b. Acute kidney injury
   c. Chronic kidney disease
8. Hematologic
   a. Anemias
   b. Hemoglobin disorders
   c. Coagulation disorders
9. Gastrointestinal
   a. Esophageal disorders
   b. Gastric disorders
   c. Pancreatic disorders (exocrine disorders)
   d. Intestinal disorders
   e. Tumors/secreting lesions
   f. Malabsorption disorders
10. Immune
    a. Infectious disorders (e.g., HIV, AIDS)
    b. Hypersensitivity disorders (Type I-IV)
    c. Autoimmune diseases
11. Other conditions

a. Cancer
b. Burns (inhalational, cutaneous)
c. Trauma
d. Substance use disorder (alcohol, nicotine, other)
e. Sepsis

C. Pharmacology

1. General principles
   a. Pharmacodynamics
   b. Pharmacokinetics
   c. Pharmacology-related mathematics
2. Inhalation anesthetics
3. Intravenous anesthetics and antagonists
   a. Barbiturates
   b. Sedative/hypnotics (e.g., propofol, etomidate, ketamine, dexmedetomidine)
   c. Benzodiazepines and benzodiazepine antagonists
   d. Opioid agonists, agonist-antagonists, and antagonists
4. Depolarizing and nondepolarizing neuromuscular relaxants and antagonists
5. Local anesthetics
6. Lipid emulsion
7. Regional anesthesia adjuncts (neuraxial and peripheral)
8. Anticholinergics/cholinergic agonists
9. Non-opioid analgesics
10. Cardiovascular medications
    a. Inotropes
    b. Phosphodiesterase inhibitors
    c. Cardiac glycosides (e.g., digitalis)
    d. Alpha- and beta-receptor agonists and antagonists
    e. Centrally acting alpha$_2$-adrenergic agonists
    f. ACE inhibitors
    g. Angiotensin II receptor inhibitors
    h. Vasodilators
    i. Nitric oxide
    j. Antidysrhythmics
    k. Calcium channel blockers
11. Bronchodilators
12. Psychopharmacologic therapy
    a. Antidepressants
    b. Antipsychotics
    c. Antiparkinsonian drugs

    d. Others
13. Prostaglandins
14. Histamine receptor antagonists
15. Antiemetics
    a. 5-HT_3 receptor antagonists
    b. Gastrointestinal prokinetic medications (metoclopramide)
    c. Antacids
    d. Other
16. Insulin
17. Hypoglycemics
18. Diuretics
19. Anticoagulants and antagonists
    a. Heparin and low-molecular-weight heparins
    b. Heparin reversal—protamine
    c. Antiplatelet medications
    d. Oral anticoagulants
    e. Oral anticoagulant reversal
    f. Thrombolytics
    g. Thrombin inhibitors
20. Procoagulants (e.g., antifibrinolytics, DDAVP)
21. Antimicrobials and antivirals
22. Antiepileptics
23. Lipid-lowering agents
24. Herbal remedies and dietary supplements
25. Minerals and electrolytes
26. Dantrolene
27. Steroids (e.g., dexamethasone, hydrocortisone)
28. Tocolytics
29. Uterotonics
30. Intravenous dyes
31. Cannabinoids

D. Applied chemistry, biochemistry, physics, and mathematics

1. Chemistry and biochemistry
    a. Aqueous solutions and concentrations
    b. Acids, bases, and salts
    c. Chemical reactions: oxidation, reduction, hydrolysis, and conjugation
    d. Metabolism
    e. Cellular mechanisms of action
    f. Drug receptor interaction
2. Physics

a. Units of measurement
b. Gases and gas laws
c. Solubility, diffusion, and osmosis
d. Pressure and fluid flow
e. Electricity and electrical safety
f. Vaporization and humidification
g. Measurement of oxygen, carbon dioxide, and hydrogen ions

3. Nonpharmacology-related mathematics

II. Equipment, Instrumentation and Technology (20%)

A. Anesthetic delivery systems

1. High/low pressure gas sources
2. Regulators/manifolds
3. Flowmeters, valves, floats
4. Vaporizers
5. Proportioning systems
6. Pressure failure safety devices
7. Failsafe devices
8. Ventilator
9. Carbon dioxide absorbents
10. Anesthetic circuits
    a. Rebreathing, circle system
    b. Nonrebreathing
    c. Modified nonrebreathing
11. Pneumatic and electronic alarm devices

B. Airway equipment

1. Face masks
2. Laryngoscope
    a. Rigid
    b. Video laryngoscope
    c. Optically enhanced scopes
3. Flexible fiberoptic bronchoscope
4. Endotracheal tube
5. Endobronchial tube
    a. Double-lumen tubes
    b. Bronchial blockers
6. Airways

a. Oral
b. Nasal

7. Tracheostomy tubes
8. Supraglottic airways (e.g., LMA)
9. Intubating supraglottic airways
10. Jet ventilation
11. Intubating stylets
12. Cricothyrotomy (needle and surgical)
13. Intubation aids (e.g., bougie, exchange catheter)

C. Monitoring devices

1. Central nervous system
   a. Evoked potential
   b. Intracranial pressure
   c. Modified EEG monitor
   d. Cerebral oximetry
2. Cardiovascular
   a. Electrocardiogram (3-lead and 5-lead)
   b. Arterial pressure monitoring
   c. Noninvasive blood pressure monitoring
   d. Central venous pressure monitoring
   e. Pulmonary artery pressure monitoring/SvO_2
   f. Hemodynamic monitoring
   g. Precordial/esophageal stethoscope
   h. Transesophageal echocardiogram
3. Respiratory
   a. Capnography
   b. Airway gas analysis
   c. Pulse oximetry
   d. Airway pressure
   e. Blood gas analysis
4. Others
   a. Peripheral nerve stimulator (qualitative and quantitative)
   b. Temperature monitoring
   c. Maternal/fetal monitoring

D. Patient warming equipment

1. Fluid/blood warmers
2. Forced air warming devices
3. Heat and moisture exchanger (HME)
4. Radiant warmers

E. Infusion devices (e.g., rapid infusers)

F. Imaging and imaging safety

1. Ultrasound
2. Fluoroscopy
3. Radiography

III. General Principles of Anesthesia (35%)

A. Ethical considerations

1. Autonomy, beneficence, nonmalfeasance
2. Research ethics

B. Legal issues

1. Advance healthcare directives
2. Informed consent
3. Disclosure of errors/ injuries
4. Legal doctrines
5. Torts
6. Scope of practice
7. Standards of practice
8. Billing

C. Safety and wellness

1. Provider substance abuse disorder
2. Issues surrounding patient safety
3. Impaired provider
4. Wellness initiatives and peer assistance

D. Preoperative assessment and preparation of patient

E. Fluid volume assessment and management

1. Fluid/blood component therapy replacement (including plasma expanders)
2. Bloodless medicine (including blood salvage devices and hemodilution techniques)
3. Goal-directed fluid management (crossover with equipment)
4. Massive transfusion protocol

5. Thromboelastography

F. Positioning

1. Techniques
2. Physiologic alterations
3. Complications

G. Utilization and interpretation of testing data

1. Lab tests (blood gases, activated clotting time)
2. Diagnostic exams (including basic 12-lead ECG interpretation)

H. Airway management

1. Assessment
2. Techniques, procedures, and devices
3. Complications
4. Difficult airway management (difficult airway algorithm)

I. Local/regional anesthetics (technique, physiologic alterations, complications)

1. Anatomy
2. Infiltration
3. Topical
4. Neuraxial blocks
5. Peripheral blocks
6. Other blocks (airway, retrobulbar)
7. Ultrasound and/or nerve stimulator guided concepts and techniques
8. Management of complications (e.g., local anesthetic systemic toxicity)

J. Light, moderate, and deep sedation (monitored anesthesia care)

K. Total intravenous anesthesia

L. Pain

1. Pain theory (anatomy, physiology, pathology, and psychodynamics)
   a. Acute
   b. Chronic
2. Pain management
   a. Acute
   b. Chronic

c. Multimodal pain therapy

M. Enhanced recovery after surgery (ERAS)

N. Hypotensive technique and risks

O. Postanesthesia care/respiratory therapy

P. Infection control

1. Provider (e.g., personal protective equipment, room air handling, ultraviolet sanitizers)
2. Patient (e.g., aseptic technique, workstation cleanliness, needle safety)

Q. Intraoperative fire safety

IV. Anesthesia for Surgical Procedures and Special Populations (25%)

A. Surgical and diagnostic anesthesia, including management of complications

1. Intra-abdominal
   a. Hepatobiliary system
   b. Gastrointestinal tract procedures
   c. Endocrine organ procedures
   d. Renal/genitourinary
   e. Gynecologic procedures
   f. Peritoneal procedures (including hernia repair)
2. Extrathoracic
   a. Breast
   b. Plastics and/or reconstructive
3. Head
   a. Extracranial
      i. Otolaryngological
      ii. Ophthalmologic
      iii. Nasal
      iv. Craniofacial
      v. Plastics and/or reconstructive
      vi. Orthodontic/dental
   b. Intracranial
      i. Decompression (burr holes, ventriculoperitoneal shunt)

    ii. Space-occupying lesion
    iii. Vascular
    iv. Transsphenoidal hypophysectomy
    v. Stereotactic procedures
4. Cardiac anesthesia
    a. Open procedures (e.g., coronary artery bypass grafting)
    b. Minimally invasive procedures (e.g., transcatheter aortic valve replacement/implantation [TAVR/TAVI], left atrial appendage closure implant, mitral clips)
    c. Interventional cardiology (e.g., pacemakers, automated internal cardiac defibrillator devices, electrophysiology cases)
    d. Management of patients with cardiac devices (e.g., ventricular assist device, extracorporeal membrane oxygenation, intraarterial balloon pump)
5. Noncardiac intrathoracic (including open and thoracoscopic approach)
    a. Diaphragm
    b. Endoscopic procedures (bronchoscopy, mediastinoscopy)
    c. Esophagus
    d. Lung
    e. Mediastinum
6. Neck
    a. Larynx/trachea
    b. Lymph node biopsies
    c. Parathyroid/thyroid
    d. Neck tumors
7. Neuroskeletal
    a. Cervical spine (anterior and posterior approach)
    b. Laminectomy/discectomy fusions at all levels
    c. Pain management procedures
    d. Other
8. Orthopedic
    a. Arthroscopic procedures
    b. Closed reduction
    c. Fractures
    d. Total joint replacements/arthroplasty
    e. Procedures of the hand and foot
9. Perineal and pelvic procedures
    a. Gynecologic
    b. Genitourinary
    c. Anal/rectal
10. Vascular (open versus endovascular)
    a. Carotid

b. Thoracic
c. Abdominal (including renal)
d. Extremity
    i. Occlusive disease
    ii. Vascular access
e. Thromboembolic prevention
f. Surgical management of portal hypertension

11. Non-operating-room anesthesia (NORA)
    a. Diagnostic imaging and radiology
    b. Electroconvulsive therapy
    c. Interventional radiology
    d. Radiation therapy
    e. Endoscopy
12. Robotic/laparoscopic surgery
13. Other surgical procedures
    a. Trauma
    b. Burns
    c. Organ transplants (including management of posttransplant patient for nontransplant surgery)
    d. Organ procurement
    e. Laser procedures

B. Anesthesia for special populations

1. Pediatrics
    a. Anatomy, physiology, and pathophysiology
        i. Normal
        ii. Prematurity
        iii. Congenital abnormalities
    b. Pharmacology
    c. Anesthesia techniques/procedures
    d. Management of complications
2. Obstetrics
    a. Anatomy, physiology, and pathophysiology
    b. Pharmacology
    c. Anesthesia techniques/procedures
    d. High-risk parturients
    e Nonobstetric surgery in the parturient
    f. Management of complications (e.g., amniotic fluid embolism, HELLP syndrome)
    g. Postpartum hemorrhage
3. Geriatrics

a. Anatomy, physiology, and pathophysiology
b. Pharmacology
c. Anesthesia techniques/procedures
d. Management of complications (e.g., postoperative cognitive dysfunction)

4. Obesity
   a. Anatomy, physiology, and pathophysiology
   b. Pharmacology
   c. Anesthesia techniques/procedures (including bariatric)
   d. Management of complications
5. Substance use disorder population
   a. Medication-assisted therapy (MAT) (e.g., methadone, buprenorphine)
   b. Pharmacologic interactions (e.g., acute intoxication)
   c. Pain management
   d. Management of complications
6. Immune compromised and oncology patients
   a. Pharmacology
   b. Anesthesia techniques/procedures
   c. Management of complications