

Appendix 2. Clinical and Cognitive Competencies

Fellows must be able to provide safe, effective, evidence-based patient care that is compassionate and appropriate. Upon completion of the fellowship each candidate must have demonstrated independent competent performance in the following areas.

I. Perioperative Anesthesia Clinical Care

a. Assessment

- i. Assess, optimize, risk stratify then recommend preprocedure evaluation and management for patients requiring neurosurgical, spine and neuroradiology interventions.
- ii. This includes focused neurologic examination and interpretation of required studies (e.g., MRI, CT, endovascular).
- iii. Airway management, ICP, cardiovascular, pharmacologic management to optimize neurologic outcome.
- iv. Assess the need for standard physiologic monitoring and specialized procedures used for other surgical procedures.
e.g., arterial catheter, central venous catheter, pulmonary artery catheter, ultrasound, transesophageal echocardiogram.
- v. Assess the need for, then place, interpret and develop a treatment plan using invasive and noninvasive neurophysiologic monitors.
e.g., ICP monitoring, endoventricular (EVD), or lumbar drain, right atrial catheter, precordial doppler, cerebral perfusion pressure monitor (epidural and intrathecal), transcranial doppler (TCD).

b. Intraoperative Management Unique to Neuroanesthesia

- i. Apply principles of neuropharmacology and resuscitation as required.
- ii. Interpret invasive and non-invasive diagnostic studies and execute appropriate medical interventions in neurologically impaired or intact patients.
- iii. Apply principle of cerebral and spinal perfusion and pressure goals appropriately with respect to underlying neuropathology during neurosurgical or other surgical procedures.
- iv. Manage intracranial hypertension and cerebral edema using physiologic, pharmacologic, and positioning techniques.
- v. Neurophysiologic monitoring (IONM or IOM):
 1. Be aware of anesthetic considerations in surgical procedures and choose anesthetic techniques that facilitates monitoring in the anesthetized and awake patient (cortical mapping: motor, sensory, speech).
 2. Understand the neurologic pathway that is being monitored. Be able to identify and respond appropriately to differential causes, technical, pharmacologic, physiologic (e.g., hypotension, anemia) and surgical of signal degradation.
 3. Prevent neuromonitoring complications associated with patient physiology, surgical procedure and anesthetic management.
 4. Techniques include but are not limited to: auditory brainstem monitoring (auditory brainstem response (ABR), or brainstem auditory evoked potentials (BAER)), electroencephalogram (EEG-processed or diagnostic), electromyography (EMG), motor evoked potential (MEP), somatosensory evoked potential (SEP or SSEP), sensory or motor nerve conduction (SNAP) and muscle contraction (CMAP) and direct cortical or spinal cord mapping.
- vi. Demonstrate anesthesia management proficiency based on surgical situation for deep brain stimulation (DBS) procedures, awake and anesthetized, multiorgan trauma, all vascular (e.g.,

- aneurysm, arteriovenous malformation, cerebrovascular disease) and tumor procedures (intracranial, spinal, peripheral vascular).
- vii. Recognize and competently manage unique surgical, physiologic and clinical risks associated with supratentorial, posterior fossa, base of skull (e.g., transsphenoidal pituitary, craniopharyngiomas, vestibulocochlear therapies), spinal cord, spine, and peripheral nerve positions and specific disorders seizures surgical pathologies.
 - viii. Management proficiency includes selection and use of monitors, fluid and cardiovascular management, drug selection, appropriate positioning to prevent injury and postoperative follow up long term outcome.
 - ix. Management proficiency in positioning including supine, prone, sitting, lateral for a neurosurgical and spine procedures.
 - x. Recognize interference on hemodynamic monitors.
 - xi. Adapt neuroanesthesia management in all surgical situations as requested.

c. Spine Intraoperative Management

Spine intraoperative management encompasses both structural spine and spinal cord procedures that are a combination of instrumentation in cervical, thoracic and lumbar spine, as well as spine and spinal cord pathologies (tumors, trauma, idiopathic and degenerative scoliosis, spinal stenosis and other degenerative or inflammatory disease). Additional areas of expertise include:

- i. Positioning-prone, supine, lateral
- ii. Blood loss-hemodynamic instability
- iii. Coagulopathy
- iv. Cardiovascular management
- v. Chronic pain management
- vi. Minimally invasive procedures
- vii. Neurologic injury, intraoperative neuromonitoring
- viii. Postoperative visual loss

d. Postoperative Management

Provide transfer of care based on expertise in both postanesthesia skills and neurocritical care management principles.

e. Clinical Procedures

Upon completion of the fellowship each candidate must have demonstrated independent competency in interpretation and/or placement of the appropriate procedures based on availability in local practice:

- i. Interpretation and consultation of intraoperative neuromonitoring: electroencephalogram (EEG), processed EEG, electrocorticogram, evoked potentials and electromyogram (EMG).
- ii. Placement and interpretation of precordial doppler, transcranial doppler, scalp blocks.
- iii. Knowledge and understanding of brain oxygen partial pressure, cerebral blood flow monitors, cerebral oximetry, jugular bulb oxygen saturation, cerebral microdialysis.

II. Neurocritical Care Module

a. Intensive Care Unit Clinical Management

- i. Evaluate and manage critical neurological illnesses, including traumatic brain and spine injury, intracranial hypertension and herniation, ischemic or hemorrhagic stroke, status epilepticus, and brain protection after cardiopulmonary resuscitation. Appreciate the emergent need for neurosurgical or endovascular intervention and be involved in physiologic optimization of patients.
- ii. Manage spinal and ventriculostomy drains, as well as intracranial pressure (ICP) monitors.

- iii. Evaluate and treat perioperative morbidities in neurological injury patients, including central nervous system infections, cerebral vasospasm, cardiorespiratory complications of neurologic injury, electrolyte and endocrine abnormalities, and other systemic infections.
- iv. Safely transport and monitor critically ill neurological patients.
- v. Evaluate and manage postoperative pain and implement analgesic regimens tailored to the limitations imposed by the patient's neurological status.

III. Interventional or Endovascular Neuroradiology

a. Anesthesia Management

- i. Understand and provide appropriate anesthetic care for various interventional neuroradiology procedures available in the sponsoring program. For example: endovascular procedures to treat aneurysm, arteriovenous malformation (avm), thrombotic or embolic vascular occlusion for vascular or tumor, stent or other treatment for vascular dissection, venous or arterial clot removal/lysis, spinal vascular procedures, vertebroplasty
- ii. Timely management of emergency procedures, such as acute ischemic stroke.
- iii. Appropriately manage anticoagulation and the drug reversal.
- iv. Develop perioperative and anesthetic management strategies to prevent procedure-related complications and minimize their effects if they occur.

b. Endovascular Procedure Module

Under direct supervision of the neurointerventionalist:

- i. Assess MRI and apply knowledge to the interventional procedure to be performed.
- ii. Discuss the procedure with risks and benefits with patient or medical power of attorney.
- iii. Assist the neurointerventionalist as directed which may include participation to observation.
- iv. Understand the decisions and outcomes from the intervention.
- v. Follow and assist in management of postoperative care.
- vi. Be able to identify and begin care intervention for common intravascular postoperative complications (e.g., vasospasm, vascular rebleed, neurologic exam suggesting progression of injury).

IV. Cognitive Module Content—Knowledge

During the clinical modules, mastery of the following advanced neuroscience concepts should occur:

a. Neuroanatomy, Neurophysiology, Neuropathology

- i. All components of the brain, spinal cord, spine, and major peripheral nerves.
- ii. Intracranial and spinal cord blood supply and blood flow regulation and hemodynamic goals in relation to the intracranial or spinal pathology.
- iii. Effects of intramural pressure, biochemical milieu, and metabolic rate on perfusion.
- iv. Principles of electroencephalography (EEG) and processed EEG, neural pathways involved in the generation of auditory, sensory and motor evoked potentials.

b. Neuropharmacology

- i. Neuro- and systemic pharmacology of anesthetics, antiepileptic drugs.
- ii. Pharmacology of fluids, sodium regulation, diuretics, and osmotherapeutic agents on the central nervous system.
- iii. Interactions between neuropathology and pharmacology of anesthetics and vasoactive drugs.
- iv. Neuroprotection and neurotoxicity and relevant pharmacology.

c. Neurological Injury Classification and Grading

- i. Grading scales for coma, stroke, subarachnoid hemorrhage, intraparenchymal hemorrhage, arteriovenous malformation and neurologic outcome.
- ii. Classification and treatment modalities of intracranial tumors; differentiation of, etc.
- iii. Radiological differentiation of mass effect, subdural vs. epidural hematoma, hemorrhagic vs. ischemic stroke.
- iv. Classification and pathophysiology of epilepsy.

d. Applied Medical Knowledge

- i. Physiology, perioperative management of pituitary tumors.
- ii. Physiology of disorders treated with minimally invasive techniques: movement disorders, obsessive compulsive disorder (OCD), seizure and perioperative concerns of surgical interventions.
- iii. Spinal cord disorders include management of cervical spine disease- unstable, immobile and stenosis, Chiari Malformation; thoracic kyphosis, scoliosis, lumbar idiopathic and degenerative disease including lumbar stenosis, meningomyelocele management.
- iv. Physiologic management of massive transfusion and hypoperfusion injury in spine procedures.
- v. Management of intracranial pressure monitoring and cerebral metabolic demands.
- vi. Mechanical ventilation modes and its implications for patients with neurological diseases.
- vii. Diagnosis and management of sodium and osmotic derangements.

e. System Learning, Business Management, and Ethics (Optional)

- i. Legal and ethical issues related to severe neurologic illness including surrogate permission, brain death, organ donation, definition and implementation of goals of care.
- ii. Principles of research in neurologically impaired patients.
- iii. Processes involved in designing and implementing clinical trials for neurological diseases.
- iv. Sound business practices and the direct and indirect costs of different neuroanesthesia analgesic and anesthetic techniques, including room allocation, staffing, and patient throughput.
- v. Organization and management of a neuroanesthesiology service, including healthcare delivery models, funding, building a service, and regional regulatory agencies with jurisdiction.

V. Organized Educational Conferences

a. Didactic Conferences:

- i. Must be held on regular basis.
- ii. Have defined cognitive and knowledge goals.
- iii. Have a required or expected audience.
- iv. Expect all participants to present appropriate material.

b. Quality Assurance Conferences:

- i. Required.
- ii. Expectation format used will reflect local custom.

c. Skills/Simulation Conferences:

- i. Have a defined technical or cognitive skill program.
- ii. Provide individual experience with the device or skill planned.
- iii. Evaluate the effectiveness of the activity.

iv. Examples: transcranial doppler, EEG placement and interpretation, assemble and use of endoventricular device.

d. Outside Conferences:

Participation in surgical, neuroradiology, neurocritical care educational activity is encouraged by the ICPNT.

e. Research:

The topics and participation in activities developed by sponsoring program.