

Appendix 3. Curriculum Modules

The one-year fellowship consists of cognitive and clinical experience-based modules that are managed by the Sponsoring Organization. It is recognized that the experience components will depend on clinical opportunities. It is recommended that, when possible, the program provide linked cognitive and clinical experiences over a discretely defined time period (rotation). However, the availability of clinical opportunities will determine the structure of the Sponsoring Organization's training experience. It is recommended that knowledge, didactic education be organized in specific modules while the acquisition of clinical experience occurs over time until the program director determines that competence is achieved.

Fellows must provide safe, effective, evidence-based patient care that is compassionate and appropriate. The local curriculum should be designed to provide the opportunity for the fellow to become, upon completion, an independent competent neuroanesthesiologist. The fellow must be cognitively and technically competent, in all areas of patient care that requires the special expertise of the neuroanesthesiologist: pre-anesthetic evaluation, intraoperative management and postoperative care of patients undergoing neurosurgical, interventional neuroradiology procedures, spine and ideally Intraoperative Neuromonitoring (IONM, IOM). A compendium of suggested knowledge, clinical care, and anesthetic experience is in Appendices 2 and 4.

The fellow should also demonstrate neurocritical care skill within the scope of training provided. A fellow should be competent to provide consultation, specialized recommendation or services for neurologically complex patients undergoing non-neurosurgical procedures.

Case numbers are required to document direct fellow involvement in accordance with ICPNT definitions. Each fellow will be de identified to the ICPNT. All performance assessments will remain with the Sponsoring Program. Using this ID, case experience logs will be reported to ICPNT. Similarly, a report that certifies the fellows' outcome will be provided to the ICPNT within 30 days of a status change (III.a.ii.5.c). The ICPNT should not receive information that would allow the fellow to be identified. All fellowship decisions are determined by the sponsoring program and the program director. Annual reports which are provided by ICPNT are needed for program renewal.

I. Training Modules and Fellow Experiences

Fellow Clinical Supervision Guidelines

- a. **Levels of Supervision:** To ensure oversight of fellow supervision and graded authority and responsibility, the program must use the following classification of supervision by clinical faculty:
 - i. **Direct Supervision** - The supervising physician is physically present with the fellow and patient.
 - ii. **Indirect Supervision** - With direct supervision immediately available.
 1. The supervising physician is physically within the hospital or another site of patient care and is immediately available to provide direct supervision and/or consultation.
 2. The supervising physician is not necessarily physically present within the hospital or other site of patient care but is immediately available by means of telephonic and/or electronic modalities and is available to provide consultation and/or direct supervision.
 - iii. Depending on institutional rules, indirect supervision and oversight may entail the fellow having an appointment as an instructor or junior faculty. Fellows will function as junior faculty in the manner expected by the institutional guidelines and local laws and regulations. Fellow activities be indirectly supervised by core faculty consultants when performing cases deemed within the practice parameters of neuroanesthesia. Fellow independence may advance to full faculty responsibilities as they

demonstrate satisfactory improvement during the training program. This decision is made by the program director with advice from the core faculty.

iv. Oversight - The supervising physician is available to provide review of procedures/encounters with feedback provided after care is delivered.

- b.** As fellows develop expertise in the care of neurosurgical, neuroradiological and structural spine patients, they will progress from being directly supervised to indirect supervision, oversight and finally independence. Fellows will develop supervisory skills for the continuum of trainees: residents and/or advanced practice non-physician individuals as is customary in local practice. Patient care requirements and cognitive goals for management of diseases and surgical anesthesia in the neurological system are provided in Appendix 2.
- c.** The fellow's clinical experience as well as the training progression to independent care will be reported in the Fellow Clinical Experience portion of the application. Submission is required within 30 days of fellowship completion. ICPNT Accreditation does not require a current fellow. Consequently, all sponsoring organizations will report the Available Clinical Experience (Appendix 4) as part of the ICPNT application submission. Updates as requested by the ICPNT are necessary to maintain accreditation.

II. Required Clinical Modules

a. Adult Neurosurgical Anesthesiology Module (minimum 24-week equivalent)

Craniotomy and spine surgery should include experience with complex surgical procedures. It is anticipated that many procedures will be available as outlined in Appendix 4. In addition to experience in standard procedures on the central nervous system, spinal cord, and spine, it is desirable but not required that fellows gain experience in anesthetic management of traumatic brain injury, surgery for movement disorders, endoscopic neurosurgery, and sitting position craniotomy. Efforts should be made to group specific procedures to maximize the depth of knowledge and clinical experience.

The ICPNT recommended minimum experience needed to acquire expertise is 50 craniotomy procedures (supratentorial, infratentorial) and 30 spine surgeries. The distribution of procedures must meet these minimum number recommendations:

- i. Five** awake craniotomies for speech, motor, and sensory mapping, may include up to two DBS surgery.
- ii. Five** craniotomies for seizure focus mapping, grid placement or seizure focus excision.
- iii. Ten** craniotomy or endovascular procedures for intracranial vascular lesions, including intracranial aneurysms, arteriovenous malformations, stroke revascularization (stroke alert).
- iv. Ten** craniotomies for tumor.
- v. Five** emergency or trauma intracranial or spine procedures
- vi. Five** spinal cord procedures for tumor or vascular treatments.

- vii. Twenty-five** structural spine surgeries that include experience with cervical and thoracic spine instrumentation.
- viii.** Five intracranial spinal fluid shunt procedures.
- ix.** Observation and interaction with a neurologist or certified IONM professional who provides monitoring for structural spine, brain mapping, vascular procedures.

When these goals cannot be met, a written explanation with the ICPNT is required.

Meeting the suggested experience in all categories not required for accreditation. However, when these targets cannot be achieved, communication with the ICPNT is needed. Accreditation requires that the ICPN fellows who successfully complete their program are able to competently manage patients presenting for procedures such as those in this list.

Appendix 4 is a tool to evaluate the breadth of clinical experience available for both the program and the ICPNT. Yearly submission of the fellows' clinical experience and the clinical material available is required.

b. Neuroradiology Module (Longitudinal activity, 4-week equivalent)

Formal and informal education regarding interpretation of Magnetic Resonance Imaging (MRI), functional MRI (fMRI) and Computed Tomography (CT) scans is necessary to be able to evaluate patient condition and anesthetic risk. The number and structure of this rotation is determined by the resources available. Experience in the interventional radiology suite participating with the faculty is also valuable. This activity will be reported in to the ICPNT as part of the fellow Activity Report.

Suggested components of this rotation could include:

Fellows develop competence in diagnostic as well as interventional or endovascular neuroradiology in the context of neuroanesthesiology. During this rotation, fellows should be exposed to neuroimaging modalities that are commonly employed in the care of neurologic patients. When available, fellows experience should include participation in the interventional neuroradiology team in order to develop an in-depth knowledge of therapeutic radiologic procedures. The fellows need to be able to perform a basic interpretation of brain, spinal cord and spine imaging and understand the technical aspects of interventional neuroradiology.

Fellows must be able to appropriately manage anesthesia for neuroradiological procedures, including therapy for stroke, carotid stenosis, cerebral aneurysm, vasospasm, and AVM. It is recognized that expertise acquired will vary according to clinical opportunity at the institution. The fundamental requirements for this rotation are in Appendix 2. The breadth of experience is evaluated in Appendix 4 and the annual clinical experience report.

The neuroradiology anesthesia module may be merged with the adult neurosurgical anesthesiology module, thereby increasing the merged module to achieve 24-week time equivalent.

c. Neurocritical Care Module (4-week equivalent)

During this rotation fellows will manage critically ill patients, with a focus on neurological or neurosurgical problems, for preoperative evaluation and preparation, and the postoperative care of neurosurgical patients. The fellows will participate in clinical and teaching rounds, and actively manage the care of these patients. This management should include invasive lines, airway management, monitoring of ICP and cerebral perfusion pressure, and understanding the role of multimodal intracranial monitoring (even if not locally employed).

Fellows will actively manage issues arising from the underlying neurologic condition, such as intracranial hypertension, cerebral vasospasm, and the systemic complications of brain injury (including cardiorespiratory, electrolyte, coagulation, and endocrine problems), as well as other common ICU problems

including sepsis, systemic shock, and multiple organ failure and learning the interactions of these pathologies on the central and peripheral nervous system.

Patient care requirements and cognitive goals for this rotation are provided in Appendix 2. Responsibilities expected or performed are evaluated in Appendix 4 and Fellow Clinical Experience portion of the application.

d. Intraoperative Neuromonitoring Module (IONM) (Longitudinal, 4-week equivalent)

While working under the direction of a faculty, the fellows develop the ability to understand the indications and applications of neuromonitoring modalities for complex intracranial surgery, spine surgery, and carotid endarterectomy, cardiac and aorta procedures. During this rotation the fellow should learn from the appropriate professional both the interpretation and technical aspects of obtaining IONM signal. This provides the knowledge basis to evaluate the neuromonitoring data and the interactions with anesthesia management from drug selection, cardiovascular control to appropriate positioning. Intraoperative neuromonitoring is used to guide surgical procedures and potentially avoid surgical complications. The specially trained neuroanesthesiologist may be responsible for anesthesia management and/or monitoring, interpreting the electroencephalogram (EEG) and evoked potentials, while a neuromonitoring technician performs the recording. A remote or in operating room neurologist or neurophysiologist may direct the technician and interpret the finding. Intraoperative EEG monitoring or electrocorticography can be performed to identify and excise epileptogenic foci in the brain or for other cortical function mapping. Intraoperative EEG is also performed during neurovascular surgeries including, but not limited to carotid endarterectomy or application of temporary artery clipping during aneurysm or arteriovenous malformation surgery, when EEG pattern changes are monitored to confirm adequacy of intracranial blood flow. Other neuromonitoring modalities include ICP monitoring, transcranial Doppler sonography, cerebral oximetry and PbO₂, and processed EEG techniques.

The fundamental knowledge and experience requirements for this rotation are in Appendix 2.

e. Clinical Neuroscience Scholarship Module (Longitudinal, significant experience distributed throughout the fellowship, 4-week equivalent)

This module requires mentoring of the fellow by an attending faculty with experience in scholarly projects in the field of neuroscience. The mentor need not be a neuroanesthesiologist and the level of support and advice will depend on the fellow's experience. It is expected that the fellow will gain experience in oral presentation skills and submit written work for publication as appropriate. This module should likely be planned and initiated early in the year, so that the fellow has adequate time to pursue the academic project. It is expected that substantial basic or translational neuroscience projects would require a second year of fellowship/postdoctoral training. It is desirable that the fellows present their scholarly projects at the annual meeting of SNACC or other regional or international scientific meetings or interest groups with neuroscientific focus or component. This module may require a completed project for successful completion.

This module can involve:

- i.** Designing and conducting a clinical investigation or quality improvement initiative related to neuroanesthesiology, neurocritical care, or a related discipline.
- ii.** Preparation of a review article, book chapter, case report/series, or a database project.
- iii.** Preparation and presentation of lecture(s), journal clubs, or seminar(s) with concurrent provision of improvements in local educational resources (e.g. bibliography review, teaching materials, videos, podcasts, webpages, simulation scenarios, etc.) relevant to neuroanesthesiology.

III. Elective Neuroanesthesia modules.

These modules can be developed in the local organization and be under the direction of the program director and core faculty. The experience may be unique or additional concentration of time in a specific area. Where appropriate the experience can be applied to the required modules. An elective module requires a structured experience to be successfully completed.

Description of these rotations require the same rigor and structure as the seen in the required rotations. There are several possible electives described here and an additional list below.

a. *Pediatric Neuroanesthesia Module* (Recommend 4 weeks)

Fellows who desire experience in the clinical care of pediatric neurosurgical patients can be offered an elective rotation focused on pediatric neuroanesthesiology. This module would be a rotation during which the fellows will be involved in perioperative and anesthetic care of pediatric patients undergoing neurosurgical procedures including intracranial, spine, peripheral nervous system, and interventional neuroradiology. This module may be performed in a longitudinal manner. Notably, some practices include pediatric patients in a general neuroanesthesia practice and similarly such experience confers the same goals as a modular pediatric experience but also without interfering with the global educational goals of a neuroanesthesiology fellowship. With appropriate documentation and at the request of the sponsoring program, time spent in pediatric neuroanesthesia training may apply to the 24-week global clinical requirement. An independent experience in an ICPNT-sanctioned pediatric neuroanesthesiology module cannot be construed as having participated in an accredited pediatric anesthesiology fellowship unless a cooperative arrangement between pediatric and neuroanesthesiology fellowship exists.

Intracranial procedures will include all procedures similar to those applied to adults, but with more emphasis on the treatment of diseases affecting the pediatric population. Involvement of the central nervous system is frequently seen in pediatric patients with genetic and metabolic dysfunction. These patients have specific anesthetic challenges including airway issues, hydrocephalus, malignancy with massive hemorrhage, congenital anomalies of the cardiac, pulmonary and genitourinary systems, craniosynostosis, and specific limitations in the anesthetic agents that may be used. Spine cases in the pediatric population include corrective procedures with instrumentation that may involve ventilation challenges related to restrictive lung disease. Shunt placements are also an important part of pediatric neurosurgery. The fellows should also participate in the educational conferences in the pediatric anesthesia group.

This is an elective rotation. The ICPNT recommends advanced knowledge include the basic anatomic and physiologic characteristics of the central and peripheral nervous system in pediatric patients. Additional knowledge which should be considered:

- i. Pharmacologic effects of anesthetic and antiepileptic medications in pediatric patients.
- ii. Neurologic manifestations of metabolic and genetic syndromes and their implications for anesthetic management.
- iii. Indications, contraindications, and possible complications of invasive monitoring in pediatric patients.
- iv. Age- and pathology-dependent hemodynamic goals for adequate cerebral and spinal perfusion in pediatric patients.
- v. Management of increased ICP in pediatric patients.

- vi. Identification of disorders and conditions with a higher rate of uncommon but life-threatening anesthetic complications in the pediatric population such as latex allergy and malignant hyperthermia.
- vii. Issues in neonatal and pediatric anesthetic and perioperative neurotoxicity.

b. *Extended Neuroradiology Module*

Fellows develop competence in diagnostic as well as interventional or endovascular neuroradiology in the context of neuroanesthesiology. During this rotation, fellows should be exposed to neuroimaging modalities that are commonly employed in the care of neurologic patients. The fellows may also be a part of the interventional neuroradiology team in order to develop a more in-depth knowledge of therapeutic radiologic procedures. The fellows need to be able to perform a basic interpretation of brain, spinal cord and spine imaging and understand the technical aspects of interventional neuroradiology. Fellows develop experience to appropriately manage anesthesia for neuroradiological procedures, including therapy for stroke, carotid stenosis, cerebral aneurysm, vasospasm, and AVM. It is recognized that expertise acquired will vary according to clinical opportunity and experience gained by the fellow. The fundamental requirements for this rotation are in Appendix 2. The breadth of experience is evaluated in Appendix 4 and Fellow Clinical Experience portion of the application.

The recommended minimum experience needed to acquire expertise is cumulative time in neuroradiology of 20 days and 30 elective and emergent interventional neuroradiology procedures during the fellowship. However, the level of exposure should be determined by the program director and the neuroradiologist.

The neuroradiology anesthesia module may be merged with the adult neurosurgical anesthesiology module, thereby increasing the merged module to minimum 28-week equivalent.

c. *Intraoperative Neuromonitoring Experience (IONM)* (recommend 4 to 12 weeks, longitudinal)

This experience should be directed by the program resources. Outside rotations are encouraged when possible. Completion may lead to additional credentials in IONM. These may allow supervision of IONM technical personnel as well acting in a consultant capacity for surgical procedures.

d. *Additional Program Initialed Module.* (Recommend minimum of 2-4 weeks, longitudinal)

Elective rotation should reflect the expertise, experience and interest of the fellow and the resources of the Sponsoring Organization. Fellowship is an important moment to develop and investigate what may become career changing ideas and expertise. Such Training may be integrated into required components or be free standing components. Suggestions for such programs include expertise in Neurotrauma, Movement Disorders management and many others. A description of the goals, experience and measurable outcomes should accompany the ICPNT application or the final report or fellow experience at the end of the fellowship.

Suggested rotations might include (App 2 IV.e)

- Neurotrauma
- Anesthesia for Subspecialty Structural Spine Surgery
- Extended Critical Care Experience
- Anesthesia or Participation In Subspecialty of Neurosurgical Care (e.g., Deep Brain Stimulus, Awake Craniotomy, Posterior Fossa, Endovascular Procedures)
- Additional Research, Quality Improvement, Educational Simulation Projects.