



Education for Perioperative Neuroscience Excellence

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3 **PROGRAM REQUIREMENTS FOR ADVANCED TRAINING IN**
4 **Perioperative Neuroscience**
5 NEUROANESTHESIOLOGY

6
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20 INTRODUCTION ([back](#))

21

22 Residency and fellowship programs are essential dimensions of the transformation of the medical student to independent practitioner as they begin
23 the life-long continuum of medical education. This life-long educational process is physically, emotionally, and intellectually demanding, and
24 requires longitudinally-concentrated effort.

25

26 The specialty education of physicians to practice independently is largely experiential, and necessarily occurs within the context of the health care
27 delivery system. Developing the skills, knowledge, and attitudes leading to proficiency in all the domains of clinical competency requires the
28 physician fellow to assume personal responsibility for the care of individual patients. For the fellow, the essential learning activity is interaction
29 with patients under the guidance and supervision of faculty members who give value, context, and meaning to those interactions. As fellows gain
30 experience and demonstrate growth in their ability to care for patients, they assume roles that permit them to exercise those skills with greater
31 independence based on capability to synthesize knowledge into a given patient context. This concept - graded and progressive responsibility - is
32 one of the core tenets of graduate medical education. Supervision in the setting of graduate medical education assures patients safe and effective
33 care. This supervision also assures the fellow expands their skills, knowledge, and attitudes as required to independently practice of
34 neuroanesthesia and all related fields. They are prepared to become outstanding clinicians, educators and researchers, and instills in them the
35 commitment to lifelong professional growth. Fellowship furthers this process by the development of in-depth knowledge in a specific area of
36 anesthesiology beyond that acquired in specialty training. Fellows must also develop a level of subspecialty synthetic knowledge base to enable
37 them to be leaders in their respective clinical and academic departments. ICPNT is concerned with all facets of perioperative neuroscience
38 training. This document lays out minimum standards for fellowship training and program accreditation in neuroanesthesiology

39

40 **Description of Terms**

41

42 **Accreditation:** The status of a program indicating it has undergone an evaluation process resulting in recognition of meeting ICPNT- preset
43 criteria for conducting a standardized training experience which facilitates attainment of ICPNT- defined competencies.

44

45 **Case Credit:** In determining the experience of a fellow, credit for case participation, indicated in the summative evaluation transcript, is
46 warranted when the fellow is significantly involved in the cognitive aspects of the anesthetic plan and conduct of anesthesia, and
47 participates in the critical portion or portions of a procedure
48 .

49 **Competency:** An element of expertise indicating that a fellow has sufficient familiarity with a topic, concept, or procedure to be able to safely
50 perform or deliver that specific competency in the course of being a neuroanesthesiologist.
51

52 **Core Faculty:** Individuals identified by the program director who meet the qualification criteria identified by ICPNT in neuroanesthesiology,
53 have a role in training and evaluating the candidates within a program. They may also be called core attending physicians or core
54 consultants according to the vernacular of the local institution.
55

56 **Fellow:** An individual who is a trainee in a fellowship program. In this capacity the fellow, who otherwise can conduct an anesthetic
57 independently may be granted varying degrees of autonomy as judged appropriate by the program director. In situations of an
58 enfolded (in-residency) fellowship, wherein the fellow will not have been fully trained in anesthesiology, it would be expected
59 that supervision will be consistent with the fellow's level of experience.
60

61 **Fellowship:** A post-graduate subspecialty training experience acquired during or after specialty training in anesthesiology. Fellowships are a
62 minimum of one year in duration, but may be longer as determined by the requirements of the individual program, and
63 qualifications and career goals of the trainee regarding the body of knowledge and the skills to be learned.
64

65 **Fully trained anesthesiologist:** A physician who has successfully completed a post medical school training experience in anesthesiology
66 consistent with the duration and demonstrated competencies as defined by the region or country where it is performed and who
67 can practice anesthesiology independently. A minimum of two years of clinical anesthesiology training is expected for purposes
68 of enrollment in an ICPNT accredited fellowship.

69

70 **Graduate training or education:** Training provided after graduation from medical school. It can encompass residency or fellowship types of
71 training.

72

73 **Program Director:** The person in a sub-specialty leadership position among the core faculty responsible for ensuring subspecialty trainee
74 candidates to successfully achieve curriculum-defined competencies in an ICPNT accredited program before graduating.

75

76 **Residency:** A post medical school specialty training program. In anesthesiology, a residency duration will be as mandated by the region or
77 country where it is performed.

78

79 **Subspecialty program:** An academic setting within a clinical environment, comprising of teaching faculty, with appropriate staff support and
80 facilities, which altogether delivers a curriculum to train subspecialists within a defined time period

81

82 **Synthetic Knowledge:** Synthesizing (based on Bloom's taxonomy) involves building a structure or pattern from diverse elements of
83 perioperative neurosciences which is accepted within the framework of the ICPNT; it also refers to the act of putting parts
84 together to form a whole. Its characteristics include: production of a unique communication, production of a plan, or proposed set
85 of operations, derivation of a set of abstract relations...all related to combining and integrating a diverse combination of clinical
86 and basic neurosciences knowledge relevant to neuroanesthesiology. Achieving synthetic knowledge is the goal of a fellowship
87 which differentiates the neuroanesthesiology training experience from that acquired during residency.

88

89

90 **I. DEFINITION AND SCOPE OF EDUCATION** ([back](#))

91

92 **A. Definition of Neuroanesthesiology**

93

94 Neuroanesthesiology is the subspecialty of anesthesiology devoted to the comprehensive anesthetic and perioperative management of patients
95 undergoing surgical and interventional neuroradiology procedures on the central and peripheral nervous systems.

96

97 Neuroanesthesiologists can be involved in the overall care of neurosurgery and neuroradiology patients as well as patients with
98 neurological disease who are undergoing any surgical procedure that places any component of the nervous system at risk; and are likely
99 to be more involved in such patients as healthcare evolves. The most unique area of knowledge is in the area of providing support for
100 patients undergoing neurosurgical and neuroradiology procedures. This entails developing a pharmacologic paradigm which provides
101 hypnosis, analgesia, immobility, and physiologic stability with appropriate systemic and neurologic monitoring, while also providing a
102 milieu which most optimally supports central nervous system physiology and neurochemistry during and after neurosurgery and
103 interventional neuroradiology procedures. This also entails providing optimal management of medical and neurological comorbid
104 conditions which may be important to an optimal outcome after the procedure.

105

106 Another unique area of knowledge has to do with the neuropharmacology of anesthetic drugs used for neurosurgery and other surgical
107 procedures. This area delves into mechanisms of anesthetic actions, potential neuroprotective and neurotoxic effects of anesthetics,
108 interactions of anesthetic and non-anesthetic drugs with the pathophysiology of neurosurgical problems as affected by the procedural
109 intervention and other intra-procedure physiologic aberrations.

110

111 Neuroanesthesiology is not just focused on intraoperative issues. Indeed, reforms in health care worldwide are supporting increasing
112 involvement of anesthesiologists in the perioperative continuum. Thus, neuroanesthesiologists are expected to be involved in activities
113 which will include perioperative and neurocritical care assessment and management of neurosurgical and neuroradiological patients.

114

115 Neuroanesthesiology also involves an understanding of issues in perioperative neuromonitoring. Given that the anesthetic paradigm
116 used for a given patient can significantly impact the data obtained from intraoperative neuromonitoring, this is an important and
117 essential body of knowledge unique to neuroanesthesiology. As such there is overlap with the growing discipline of perioperative
118 neuromonitoring.

119

120 **B. Duration and Scope of Training**

121

122 The minimum length of total neuroanesthesiology fellowship training is 12 months of which 10 months should be supervised clinical training. This
123 minimum length of supervised clinical training should be covered in a maximum length of 24 months of clinical patient care, which may be
124 discontinuous and interspersed with academic time to permit research or other nonclinical academic pursuits as a component of the overall
125 fellowship experience.

126

127 **II. INSTITUTIONAL REQUIREMENTS** [\(back\)](#)

128

129 **A. Sponsoring Programs**

130 **1. Sponsoring Institution** A single sponsoring institution must assume ultimate responsibility for the program, and this
131 responsibility extends to fellow assignments at all participating sites within the sponsoring institution.

132 **a.** The sponsoring institution and the fellowship program must ensure that the program director has sufficient protected time
133 and financial support for their educational and administrative responsibilities to the program.

134 **b.** It is recommended that the sponsoring institution also sponsor an accredited (according to regional standards) residency
135 program in anesthesiology.

136 **2. Participating Sites** There must be a program letter of agreement (PLA) or equivalent between the program and each
137 participating clinical site providing a required experience. The PLA must be renewed at least every five years. The PLA should:

138

139 **a.** Identify the faculty who will assume both educational and supervisory responsibilities for fellows.

140 **b.** Specify their responsibilities for teaching, supervision, and formal evaluation of fellows, as specified later in this
141 document.

142 **c.** Specify the duration and content of the educational experience.

143 **d.** State the policies and procedures that will govern fellow education during the assignment.

144 **e.** Identify the institutional official who oversees the selected program director

145

146 **B. Setting**

147 The setting for a neuroanesthesiology educational program must encompass a clinical program which includes the operating suite, post anesthesia
148 care area, interventional radiology suite, surgical critical care/therapy unit or neurological critical care/therapy unit, and perioperative
149 neuromonitoring. This education may take place in various settings that provide for the care of critically and neurologically ill adult and pediatric
150 surgical patients, including those with traumatic injuries, cerebrovascular insults, neuro-oncologic/infectious disorders, status epilepticus,
151 neuromuscular, and spine and spinal cord disorders

152

153 **C. Procedure Sites and Intensive Care Unit Beds**

154 The institution must have operating suite and interventional radiology facilities sufficient to support performance of the numbers of procedures
155 needed to fulfill the fellowship requirements. In addition, the institution must have a Neurologic/Neurosurgical Intensive Care Unit or dedicated
156 beds in a general ICU devoted to neurological and neurosurgical conditions and patients. In institutions where all required sites to give experience
157 to any of the mentioned educational and clinical cases are not available, the program should facilitate external rotations in an alternate academic
158 program. These alternate facilities and their associated faculty should be listed in the application for accreditation for preapproval.

159

160

161 **III. PROGRAM PERSONNEL AND RESPONSIBILITIES** [\(back\)](#)

162

163 **A. Program Director**

164 **1. Qualifications of the program director:**

165 **a.** Requisite specialty expertise and documented educational and administrative experience. This optimally includes
166 completion of anesthesiology training and three years of experience in clinical and academic neuroanesthesiology.

167 1. Such experience may take varied forms but should include involvement in the clinical practice of neuroanesthesiology
168 and supporting academic (educational or research) work.

169 2. The program director's qualifications should reflect dedication to education and capability and knowledge in relevant
170 educational methods

171 3. The program director should be willing and able to provide mentoring.

172 **b.** Current certification in anesthesiology, as available, in the region of the fellowship

173 **c.** Current medical licensure and appropriate institutional medical staff appointment as appropriate for the geographical
174 locale of the fellowship program. Current appointment as a member of the anesthesiology faculty devoting a significant
175 part of their clinical time (which can include academic and administrative effort) to neuroanesthesiology.

176 **d.** Demonstrated ongoing academic achievements over the prior ten years in at least one of the following:

177 1. Publications

178 2. The development of educational curriculums

179 3. Significant involvement in neuroanesthesia educational efforts directed to residents

180 4. Invitations to deliver regional, national, or international educational lectures and seminars relevant to
181 neuroanesthesiology, or;

- 182 5. The conduct of research
- 183 e. A member in good standing of the Society for Neuroscience in Anesthesiology and Critical Care (SNACC). This is
184 deemed important to foster communications between and among program directors and ICPNT, which is administratively
185 in SNACC. Facility to communicate in English is an expected attribute of the program director.
- 186 2. **Program Director Responsibilities** The program director must administer and maintain an educational environment
187 conducive to educating the fellows in each of the delineated competency areas. The program director shall:
- 188 a. Prepare and submit all information required and requested by the ICPNT
- 189 b. Be familiar with and oversee compliance with ICPNT policies and procedures, available on the ICPNT web page
- 190 c. Obtain review and approval of the sponsoring institution’s general medical office or Designated Institutional Official, or
191 equivalent local institutional oversight official (which may be the chair or head of anesthesiology or local equivalent),
192 before submitting to the ICPNT information or requests for the following:
- 193 1. Applications for ICPNT accreditation of new programs;
- 194 2. Major changes in program structure outlined in original application;
- 195 3. Fellowship program citations, and responses to all proposed adverse actions regarding the fellowship program;
- 196 4. Voluntary withdrawal as a ICPNT-accredited program;
- 197 5. Requests for appeal of an adverse action regarding the fellowship program.
- 198

218 basis for each should be provided

219 **o.** Upon successful completion of the fellowship provide to the graduating fellow an institutional certificate of completion of
220 the fellowship. As allowed by institutional protocols the certificate should indicate that the completed fellowship was
221 accredited by the International Council on Perioperative Neuroscience Training of the Society for Neuroscience in
222 Anesthesiology and Critical Care. Upon notification of successful completion of the fellowship by the program director
223 ICPNT will also issue a certificate indicating that the successfully completed fellowship was accredited by the ICPNT.

224

225 **B. Core Faculty**

226 **a.** A neuroanesthesiology fellowship training program should have dedicated faculty for mentoring, training, providing
227 feedback, and evaluating performance of the trainees.

228 **b.** There must be at least two core faculty members (including the program director) with documented qualifications to
229 instruct and supervise all fellows.

230 **c.** The neuroanesthesiology training program core faculty should have the following qualifications:

231 1. The core physician faculty must possess current medical licensure as appropriate to the geographic region and
232 possess appropriate institutional medical staff appointment.

233 2. The core physician faculty must have current certification in anesthesiology as regionally required or possess
234 other acceptable qualifications or experience that allows the practice of anesthesiology.

235 3. The core physician faculty must have neuroanesthesiology, Neurocritical Care, or Neuromonitoring fellowship
236 education or significant experience, secondary certification (or completed training) in Neurology or Neurosurgery,
237 or at least 3 years of post-residency experience in respective subspecialties with a significant portion of their
238 practice (or academic time) directed towards patients with neurological diseases.

- 239 4. The core faculty physician must have a current appointment as a member of the academic anesthesiology faculty
240 5. The core physician faculty should be academically productive in a fashion relevant to neuroanesthesiology with at
241 least one of the following: publications, educational experience, documented educational activities, or the
242 conduct of research.
243 6. The core physician faculty should be appointed by the program director.
244 7. It is recommended that the core faculty be members in good standing of a professional neuroscience-oriented
245 organization or interest group
246

247 **C. Ancillary Faculty**

- 248 a. The ancillary faculty must devote sufficient time to the educational program to meet the supervisory and teaching
249 responsibilities required by the neuroanesthesiology program director and demonstrate a strong interest in the education of
250 neuroanesthesiology fellows.
251 b. Ancillary faculty will be responsible to teach, supervise, and provide formal feedback and evaluations of fellows
252 c. Ancillary faculty must participate in the program's didactic educational program
253 d. This faculty must participate in the formal and transparent selection process for neuroanesthesiology fellows as desired by
254 the program director
255 e. Ancillary faculty must be familiar with and must contribute to the review and /or revision of the educational goals of the
256 program as desired by the program director
257 f. Ancillary faculty must be willing to supervise/organize/educate any fellow including develop a rotation for the fellowship
258 for which they are appropriately experienced and as requested by the program director
259

260 **D. Adjunct Faculty**

261 **a.** In addition to the core faculty who are mainly neuroanesthesiologists, faculty from other subspecialty training programs
262 (such as neurological intensive care, pediatric anesthesiology, neurosurgery, neurology, pain management, interventional
263 neuroradiology neuroscience research or other expertise relevant to neuroanesthesia practice) will also be involved in
264 training and evaluation of fellows as determined by the program director. The professional qualifications of these external
265 adjunct faculty need to be approved by the program director and included in the fellowship program accreditation
266 application. These faculties may include:

- 267
- 268 1. Physician faculty who do not fulfill qualifications for core neuroanesthesiology faculty but who possess significant
269 experience in Perioperative Neurosciences (neuroanesthesiology, pediatric neuroanesthesiology, intraoperative
270 neuromonitoring, Neurocritical care, neurosurgery, neurology, neuroradiology or neuroscience research, etc.).
271 They may also serve as fellowship core faculty and supervise one or more fellowship rotations on the request of
272 the program director.
 - 273 2. Noncore neuroscientist faculty- faculty who are not clinicians and do not fulfill qualifications for core faculty but
274 with significant experience in clinical or basic neuroscience may also serve as fellowship faculty and supervise
275 one or more fellowship rotations on the request of the program director.
 - 276 3. Non-physician program personnel – qualified technicians (e.g. perioperative neuromonitoring technicians,
277 transcranial Doppler sonographers, and research staff), advanced practice medical professionals may contribute to
278 the training of the neuroanesthesiology fellows.

279 **b.** Qualifications of the non-physician faculty are as follows:

- 280 1. Non-physician faculty must be appropriately qualified in their fields.
- 281 2. Non-physician faculty must possess appropriate institutional appointments and licensure as required by the
282 institution and regional laws and regulations.

283

284

E. Administrative Personnel

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286

A well-functioning program requires administrative support in the form of sufficient appropriately equipped and supplied personnel to enable

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performance of support functions such as scheduling, organizing educational events, and reporting activities and educational statistics to ICPNT.

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IV. Resources [\(back\)](#)

291

292

- A.** The institution and the program must jointly ensure the availability of all necessary professional, technical, and clerical personnel for the effective administration of the program

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295

- B.** There must be operating suites designed and equipped for the management of complex neurosurgical patients

296

297

- C.** There must be a Neurocritical care service with specialized nursing for Neurocritical care which may be a component of a general intensive care (or therapy) unit

298

299

300

- D.** There must be dedicated Neuroradiological services capable of performing CT scanning, MRI, Neuroangiography, and interventional neuroradiology procedures

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303

- E.** Intraoperative Neuromonitoring services are a desired but not required attribute. When not locally available there should be wherewithal to gain exposure to such services elsewhere at the discretion of the program director

304

305

306 **F.** There must be prompt access to consultation with other disciplines, including cardiology, critical care medicine, emergency
307 medicine, neurology, pulmonology, laboratory medicine and surgical fields. There must be allied health staff and other support
308 personnel necessary for the comprehensive care of patients with acute neurological illness

309

310 **G.** Medical Information Access. Fellows, faculty, and staff must have ready access to specialty-specific and other appropriate
311 reference material in print or electronic format. Internet-based medical literature databases with search capabilities and
312 institutional access to research publications should be available

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314

315 **V. Fellow Appointments** ([back](#))

316

317 **A. Eligibility Criteria.**

318

319

Each fellow must

320

a. Be eligible for a medical license (full and independent, training, or institutional) as required by law and applicable to the institution(s) participating in the fellowship program.

321

322

b. Have successfully completed an accredited (as customarily defined in the relevant region) Anesthesiology residency, or

323

c. For an enrolled (during residency) fellowship, be a resident in good standing in an accredited residency program (as customarily defined in the relevant region) and having completed at least two years of clinical anesthesiology residency; and an expectation of completion of residency training after completion of the fellowship

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325

326

1. The program must document that each fellow has met the eligibility criteria.

327

2. The program must adhere to Code of Ethics and Professional Conduct of the World Health Organization relating to non-discrimination in selection of fellows

328

329

(http://www.who.int/about/ethics/code_of_ethics_full_version.pdf)

330

331 **B. Number of Fellows**

332

333 The program's educational resources must be adequate to support the number of fellows appointed to the program. The number of fellows cannot
334 exceed the number of core faculty. The presence of other learners or staff members must not interfere with the appointed fellows' education. A
335 fellowship program without enrolled fellows can be accredited.

336

337 **VI. Educational Program** ([back](#))

338

339 **A. Competencies:**

340 The program must integrate the following competencies into the curriculum:

341

342 **a. Patient Care and Procedural Skills.** Fellows must be able to provide safe, effective, evidence-based patient care that is
343 compassionate and appropriate. Under the direction of faculty member's fellows must demonstrate:

344 **1.** The ability to provide clinical consultation for neurosurgical and neuroradiology patients, including assessment of
345 the appropriateness of a patient's preparation for surgery / interventional neuroradiology

346 **2.** The ability to provide clinical consultation for non-neurosurgical patients with neurological diseases, regarding
347 assessment of the appropriateness of a patient's preparation and clinical management and monitoring for non-
348 neurological surgery or interventional radiology.

349 **3.** Competence in patient management and peri-operative care of neurological patients for neurosurgery or
350 interventional neuroradiology.

351 **4.** Capability to independently execute all procedures relating to the area of neuroanesthesiology performed in the
352 region of practice. Recommended procedures include:

353 i. Intra arterial cannulation

354 ii. Central venous cannulation

355 iii. Processed EEG

356 iv. Precordial Doppler

357 v. Scalp blocks

358 vi. Advanced airway management for unstable or immobile c-spine includes fiberoptic, video

359 laryngoscopic intubations and LMA techniques as well as administration of appropriate sedation or

- 360 anesthesia.
- 361 **5.** Competence in the comprehensive anesthetic management of patients undergoing neurosurgical or neuroradiology
- 362 procedures (as specifically delineated in the fellowship modules). This must include:
- 363 i. Pre-operative assessment, optimization and risk stratification. Obtaining the appropriate diagnostic
- 364 testing and consultation and communication with the multi-disciplinary team.
- 365 ii. Airway management
- 366 iii. Hemodynamic management
- 367 iv. Anesthetic drug administration
- 368 v. Safe positioning
- 369 vi. Appropriate interpretation of EEG and evoked potential data acquired during anesthesia.
- 370 vii. Provision of anesthetic support which accommodates needs for valid interpretation of intraoperative
- 371 evoked potential or EEG monitoring
- 372 viii. Interpretation of relevant neuroimaging, neuromonitoring, and laboratory results
- 373 ix. Perioperative Neuroprotection and Neuro-resuscitation
- 374 x. Post anesthesia recovery and neurocritical care management
- 375 xi. Management of a ventricular and spinal drain.
- 376 xii. Detection and management of venous air embolism, hemorrhage, and other complications
- 377 xiii. Monitoring and management of patients with brain edema, intracranial hypertension, cerebral
- 378 ischemia, and epilepsy
- 379 xiv. Provision of anesthetic support which accommodates needs for awake craniotomy
- 380 xv. Perioperative pain management
- 381 **6.** Capability to understand and use common Neuro ICU diagnostic and monitoring modalities including
- 382 i. Long term EEG
- 383 ii. Intracranial pressure via various types of monitors

- 384 iii. Transcranial Doppler
- 385 iv. Magnetic resonance imaging
- 386 v. Computed tomography
- 387 vi. Evoked potentials
- 388 vii. Electromyogram
- 389 viii. Cerebral angiography
- 390 ix. Transthoracic echocardiography

391 7. Capability to understand the potential roles of less common Neuro ICU diagnostic and monitoring modalities
392 including:

- 393 i. Brain oxygen partial pressure
- 394 ii. Cerebral blood flow by various techniques
- 395 iii. Jugular bulb oxygen saturation
- 396 iv. Cerebral microdialysis
- 397 v. Intracranial EEG

398 **b. Medical Knowledge** Fellows must demonstrate knowledge of established and evolving relevant neuroscience,
399 biomedical, clinical, epidemiological, anesthesiology, and social- behavioral sciences, as well as the synthesis and
400 application of this knowledge to patient care. Fellows must demonstrate competence in their knowledge of the following
401 areas, with specific emphasis on the anesthetic implications of the altered central and peripheral nervous system:

- 402 1. Neuroanatomy of the brain, spine, and major peripheral nerves
- 403 2. Neuro- and systemic pharmacology of anesthetic drugs
- 404 3. Intracranial and spinal blood supply, and accompanying changes in pathophysiologic conditions.
- 405 4. Principles of cerebral blood flow regulation including effects of intramural pressure, biochemical milieu, and
406 cerebral metabolic rate.

- 407 **5.** Neuroprotection and neurotoxicity and relevant pharmacology.
- 408 **6.** Pharmacology of antiepileptic drugs.
- 409 **7.** Pharmacology of fluids, sodium regulation, diuretics, and osmotherapeutic agents
- 410 **8.** Indications, contraindications, and potential complications of the following procedures:
- 411 i. Arterial catheterization,
- 412 ii. Central venous catheterization,
- 413 iii. Pulmonary artery catheterization,
- 414 iv. Noninvasive and invasive cardiac output monitoring,
- 415 v. Cerebrospinal fluid drainage catheters, ventricular and spinal
- 416 vi. Precordial Doppler sonography,
- 417 vii. Jugular venous oximetry,
- 418 viii. Intracranial pressure monitoring, and
- 419 ix. Neurophysiological monitoring
- 420 **9.** Interactions between neuropathology and anesthetic pharmacology.
- 421 **10.** Hemodynamic goals in relation to the intracranial or spinal pathology.
- 422 **11.** Interactions between vasoactive drugs and neuropathology
- 423 **12.** Grading scales for coma, subarachnoid hemorrhage, intraparenchymal hemorrhage, cranial computed
- 424 tomographic imaging, arteriovenous malformation and neurologic outcome.
- 425 **13.** Risk and benefits of patient positioning for different neurosurgical procedures
- 426 **14.** Intracranial pressure and treatment options for intracranial hypertension.
- 427 **15.** Diagnosis and management of hyper- and hyponatremia and abnormalities of plasma osmolarity
- 428 **16.** Initiation, maintenance, and reversal of anticoagulation strategies in neurosurgery and interventional
- 429 neuroradiology.
- 430 **17.** Classification and pathophysiology of epilepsy, seizures, and status epilepticus.

- 431 **18.** Pathophysiology, perioperative management, and postoperative care of patients with pituitary tumors.
- 432 **19.** Definition, diagnosis, and management of the unstable and immobile cervical spine.
- 433 **20.** Classification of intracranial tumors, their presentation, and their management.
- 434 **21.** Diagnosis and management of venous air embolism.
- 435 **22.** Benefits and risks of craniotomy in the sitting position
- 436 **23.** Legal and ethical issues related to severe neurologic illness including surrogate permission, brain death, organ
437 donation, definition and implementation of goals of care
- 438 **24.** Principles of research in neurologically impaired patients
- 439 **25.** Organization and management of a neuroanesthesiology service, including health care delivery models, funding,
440 building a service, and regional regulatory agencies with jurisdiction;
- 441 **26.** Transport and monitoring of critically-ill neurological patients
- 442 **27.** The history, breadth and scope of neuroanesthesiology;
- 443 **28.** The basic science and clinical knowledge pertaining to routine and complicated neurosurgical anesthesia care;
- 444 **29.** Related disciplines, particularly involving neurosurgery, neurology, trauma surgery, and pediatric
445 neurosurgery/neurology
- 446 **30.** Processes involved in designing and implementing clinical trials;
- 447 **31.** The impact of different anesthetic and analgesic techniques on health care resources, including room allocation,
448 staffing, and patient throughput;
- 449 **32.** Sound business practices and the direct and indirect costs of different neuroanesthetic analgesic and anesthetic
450 techniques
- 451
- 452 **c.** **Professionalism.** Fellows are expected to have already assimilated during residency training and continue to manifest
453 skills and habits related to professionalism. The program should ensure a culture of professionalism that supports patient
454 safety, personal responsibility, and culture competency. This includes practice-based learning and improvement, quality

455 improvement, respect for peers within and outside the specialty, sharing expertise as a consultant and educator,
456 interpersonal and communication skills, professionalism, and systems-based practice

457

458 **B. Didactic Component**

459

460 **a.** The didactic curriculum should be provided through journal clubs, lectures, case conferences, morbidity and mortality
461 meetings, research conferences, facilitated self-learning, and workshops, and should supplement clinical experience all of
462 which should include participation and/or leadership of fellow

463 **b.** Faculty members should lead the majority of the sessions. Conferences may be supplemented by attendance at external
464 meetings, webinars, or other methods of internet-based education

465 **c.** The didactic curriculum should include all topics previously listed as expected medical knowledge competencies

466

467 **C. Clinical Components.** This area addresses the curriculum elements that will be addressed in a clinical or practice setting. The

468 curriculum must have a goal to develop synthetic knowledge in perioperative neuroscience with capability of graduating fellows to be able
469 to incorporate principles and knowledge in neuropathophysiology, neuropharmacology, and general medicine to provide high level care to
470 patients undergoing neurosurgical and neurointerventional procedures. The clinical curriculum shall be structured to include:

471

472 **a. Clinical** (≥ 6 four-week modules) May include pediatric neuroanesthesiology with duration and number of modules as
473 defined by the program director but without interfering with the global educational goals of a neuroanesthesiology
474 fellowship.

475 **b. Critical Care of the Neurologic Patient** (≥ 1 four-week module)

476 **c. Anesthesia for Neuroradiology/ NeuroEndovascular Care** (≥ 1 four-week module or equivalent experience embedded
477 in the Clinical neuroanesthesiology rotations)

478 **d. Intraoperative monitoring** (≥ 1 four-week module or significant experience concurrently during neuroanesthesiology
479 modules)

- 480 e. **Neuroscience Scholarship** (≥ 1 four-week module or significant experience concurrently during neuroanesthesiology
481 modules)
- 482 f. **Elective Rotation** (≥ 1 four-week module)

483

484 **D. Scholarly Activities.** This area addresses the curriculum elements that will be related through scholarly activities and included:

- 485 a. Each fellow should conduct, or be substantially involved in, a scholarly project which leads to presentations, preferably by
486 the fellow, at a national or regional meeting, and/or publication. At a minimum each fellow should deliver oral
487 presentations related to their or others' research in a local context
- 488 b. Fellows must have a faculty mentor overseeing the project and any presentations or publications

489

490 **E. Educational Program Resources and Facilities**

- 491 a. The institution and the program must jointly ensure the availability of adequate resources for fellow education, as
492 defined in the specialty program requirements.
- 493
- 494 b. Clinical facilities available to support the educational mission must include:
- 495 i. A designated area or areas for neurosurgical procedures
- 496 ii. A designated area or areas for interventional neuroradiology procedures
- 497 iii. Intraoperative Neuro monitoring and advanced life-support equipment representative of current
498 levels of technology;
- 499 iv. A Neurocritical care service with specialized nursing for Neurocritical care which may be a
500 component of a general intensive care (or therapy) unit.
- 501 v. A clinical laboratory that provides prompt and readily available diagnostic and laboratory
502 measurements pertinent to the care of critically ill neurological patients

522 **VII. Description of Fellowship Rotations (back)**

523
524 The one-year fellowship consists of 4-week modules (which can be divided into two week blocks if needed) which include:

525
526 **A. Description of Rotations**

527
528 **a. Adult Clinical Surgical Neuroanesthesiology (≥6 four-week modules)**

529
530 **1. Curriculum**

531
532 Each fellow, who successfully completes the fellowship, should be cognitively and technically competent, at an advanced synthetic level, in the
533 preanesthetic evaluation and perioperative management of patients undergoing neurosurgical and interventional neuroradiology procedures. These
534 include intracranial, spine, and peripheral nerve surgeries, as well as interventional neuroradiologic procedures, which are described separately.

535 The rotation for Adult Neurosurgical Patients consists of six mandatory modules. During this rotation, fellows develop expertise in the care of
536 neurosurgical patients, including supervision or direct patient care of supra and infratentorial craniotomy, and complex spine. surgery, including
537 spinal instrumentation procedures and encompassing a mixture of spine cases including cervical, thoracic, and lumbar spine, as well as variety of
538 pathologies (such as spinal tumors, trauma, scoliosis, degenerative diseases, oncologic). Craniotomies should include experience with
539 awake/sedated craniotomy, craniotomy for seizure focus localization and resection, and craniotomy for intracranial vascular lesions including
540 intracranial aneurysm and arteriovenous malformation. In addition, fellows should be involved in the management of intracranial cerebrospinal
541 fluid shunt procedures. It is anticipated that many craniotomies will be for the resection of mass lesions such as tumors but it is desirable that the
542 fellows gain experience in anesthetic management of traumatic brain injury, endoscopic neurosurgery, and sitting position craniotomy. The 4-
543 week interventional neuroradiology rotation (described below) may be included as one of the six mandatory adult neuroanesthesia rotations,
544 conducted as part of the neuroanesthesia experience or as a distinct rotation.

545
546 The over-arching goal is acquisition of an advanced degree of expertise in the management of such procedures. The acquisition of such expertise
547 will vary according to complexity, supervision, and responsibility borne by the fellow. The recommended minimum experience needed to acquire
548 expertise is:

- 549
- 550
- 50 Neurosurgical procedures (supratentorial, infratentorial, spinal cord) that include
 - 5 awake craniotomies, (including deep brain stimulator placement)
 - 5 craniotomies for seizure focus localization or excision,
 - 10 craniotomies for intracranial vascular lesions, including intracranial aneurysms and arteriovenous malformations.
 - 30 spine surgeries, 20 of which should include instrumentation.
 - 5 intracranial spinal fluid shunt procedures.
 - 30 interventional neuroradiology cases including stroke recovery procedures. Further interventional neuroradiology cases are listed subsequently.
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559 Some procedures (e.g. spine, carotid surgery) may be performed by non-neurosurgeons and can be included in the clinical experience. Case
560 numbers can be documented by a system which is determined internally in accordance with ICPNT definition of case credit, and a
561 summary of fellow case experience will be reported to ICPNT in the transcript reported in association with the summative evaluation.
562

563

564 **2. Competencies & patient care**

565

566 At the conclusion of the six (or more) modules of this rotation fellows will be competent to administer anesthesia for

- 567
- a. Craniotomy for subarachnoid hemorrhage and intracranial vascular pathology
 - b. Supratentorial and infratentorial tumor resection, including sedated/awake craniotomy.
 - c. Pituitary adenoma surgery and management of the associated endocrine abnormalities (including Acromegaly)
 - d. Spinal surgery including spinal cord injury, unstable cervical spine, immobilized cervical spine, spinal tumor resection and spinal instrumentation
 - e. Traumatic brain injury with brain compression.
 - f. Occlusive cerebrovascular disease including carotid endarterectomy
 - g. Epilepsy surgery
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- 575 **h.** Ischemic stroke requiring endovascular therapy.
- 576 **i.** Subdural and intra-parenchymal hemorrhage
- 577 **j.** Neuromuscular and movement disorders
- 578 **k.** Acute and chronic quadriplegia and paraplegia
- 579 **l.** Microvascular decompression and skull base surgery
- 580 **m.** Deep brain stimulation
- 581 **n.** Endoscopic and minimally invasive neurosurgery
- 582 **o.** Diagnostic and interventional neuroradiology including but not limited to coiling of aneurysms, embolization of
583 intracranial arteriovenous malformations and tumors, endovascular management of acute ischemic stroke, endovascular
584 treatment of cerebral vasospasm and Carotid Stent.
- 585 **p.** Procedures performed in the sitting position. This is an unusual procedure but cognitive competency should be the goal if
586 no cases appear, or use of high fidelity simulation may be employed if available.
- 587 **q.** Decompressive craniectomy for trauma or stroke
- 588 **r.** Surgical management of acute and chronic hydrocephalus (e.g. extra-ventricular drain insertion, ventriculo-peritoneal
589 shunt insertion, ventriculoscopy)
- 590 **s.** Non-neurosurgical procedures in patients with neurological/neurosurgical disease (as a consultant).
- 591 **t.** Chiari malformations
- 592 **u.** Implications of Intraoperative Neurophysiologic Monitoring and Anesthetic Management
- 593 At the conclusion of the six clinical rotations the fellow must be able to:
- 594 **a.** Perform a basic neurologic examination.
- 595 **b.** Recognize the need for and provide advanced airway management in patients with intracranial hypertension, unstable
596 intracranial vascular problems, and unstable or immobilized cervical spine

- 621 **b.** Intracranial and spinal blood supply, and accompanying changes in pathophysiologic conditions.
- 622 **c.** Principles of cerebral blood flow regulation such as autoregulation, chemoregulation, and cerebral metabolic rate.
- 623 **d.** Neuroprotection and relevant pharmacology.
- 624 **e.** Basic pharmacology of common antiepileptic drugs.
- 625 **f.** Indications, contraindications, and potential complications of the following procedures: arterial catheterization, central
626 venous catheterization, pulmonary artery catheterization, noninvasive cardiac output monitoring, cerebrospinal fluid
627 drainage catheters, precordial Doppler sonography, jugular venous oximetry, intracranial pressure monitoring, and
628 neurophysiological monitoring.
- 629 **g.** Interactions between neuropathology and anesthetic pharmacology.
- 630 **h.** Hemodynamic goals in relation to the intracranial or spinal pathology.
- 631 **i.** Grading scales for coma, subarachnoid hemorrhage, and arteriovenous malformation.
- 632 **j.** Risk and Benefits of patient positioning for neurosurgical procedures.
- 633 **k.** Intracranial pressure and treatment options for intracranial hypertension.
- 634 **l.** Initiation, maintenance, and reversal of anticoagulation strategies in cerebrovascular surgery and interventional
635 neuroradiology.
- 636 **m.** Classification and pathophysiology of epilepsy.
- 637 **n.** Pathophysiology, perioperative management and post-operative care of patients with pituitary tumors.
- 638 **o.** Pathophysiology of traumatic brain injury and spinal cord injury
- 639 **p.** Pathophysiology of ischemic stroke, intraparenchymal hemorrhage, subarachnoid hemorrhage, subdural hemorrhage, and
640 epidural hemorrhage
- 641 **q.** Definition, diagnosis, and management of the unstable cervical spine and spinal cord injury.
- 642 **r.** Classification of intracranial tumors, their presentation, and their management.
- 643 **s.** Diagnosis and management of venous air embolism.
- 644 **t.** Anesthetic management of endoscopic intracranial procedures.

- 645 u. Anesthetic management of patients with neurological/neurosurgical disease for non-neurosurgical procedures.
- 646 v. Benefits and risks of craniotomy in the sitting position.
- 647 w. Chiari Malformation, classification, surgical management and anesthesia implications.

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a. **Anesthesia for Neuroradiology (>1 four-week module)**

652 **1. Curriculum**

653

654 This rotation aims to develop competence in diagnostic as well as interventional neuroradiology in the context of neuroanesthesiology. The
655 interventional neuroradiology experience can be incorporated into the adult neuroanesthesia rotation, increasing the overall rotation to ≥ 7 four-
656 week modules or can be done separately as a ≥ 1 four-week module. Cumulative time in neuroradiology should at a minimum be 20 days or 30
657 procedures during the fellowship. During this rotation, fellows will be exposed to neuroimaging modalities that are commonly employed in the
658 care of neurologic patients. The fellows will also be a part of the interventional neuroradiology team in order to develop a more in-depth
659 knowledge of therapeutic radiologic procedures. The fellows should be able to understand basic interpretation of brain imaging and understand the
660 technical aspects of interventional neuroradiology. During the four weeks of the interventional neuroradiology module the fellows should
661 experience the preoperative, intraoperative, and postoperative management of patients who are candidates for interventional procedures.
662 The over-arching goal is acquisition of an advanced degree of expertise in the management of such procedures. The acquisition of such expertise
663 will vary according to complexity, supervision, and responsibility borne by the fellow. The suggested minimum numerical experience that is
664 recommended to acquire such expertise is **30 elective or emergent interventional neuroradiology procedures.**

665 **2. Competencies & patient care**

666

667 At the conclusion of the modules of this rotation fellows will be competent to administer anesthesia for
668 the following interventional radiology procedures

669

a. Diagnostic angiogram of the central nervous system

670

b. Diagnostic magnetic resonance imaging and computed tomography

- 671 **c.** Endovascular aneurysmal coiling or other methods of aneurysmal isolation
- 672 **d.** Endovascular embolization procedures of vascular malformations or tumors of the brain and spine
- 673 **e.** Endovascular thrombectomy
- 674 **f.** Endovascular vasodilator infusion
- 675 **g.** Endovascular angioplasty
- 676 **h.** Percutaneous CT or fluoroscopic guided vertebroplasty, biopsy, or dural puncture
- 677 **i.** Carotid Stents placement.
- 678 **j.** Neurodiagnostic tests, e.g., wada test, CO2 reactivity, balloon test occlusion.

679

680 At the conclusion of this rotation the fellow should be able to:

681

- 682 **a.** Identify the indications for emergent computed tomography (CT) or magnetic resonance imaging (MRI).
- 683 **b.** Identify indications for different neuroradiologic diagnostic modalities including functional and 3-dimensional methods.
- 684 **c.** Guide nursing or other personnel on appropriate clinical support, transport, and sedation of these patients at offsite
685 locations.
- 686 **d.** Identify the indications for interventional neuroradiology procedures in patients with acute ischemic or hemorrhagic
687 stroke, such as intravenous or intra-arterial tissue plasminogen activator administration, as well as mechanical
688 thrombolysis.
- 689 **e.** Identify the indications for emergent cerebral angiography in a patient with suspected cerebral vasospasm.
- 690 **f.** Appropriately manage anticoagulation (and reversal) in patients undergoing interventional procedures.
- 691 **g.** Identify and manage complications during and after interventional procedures.
- 692 **h.** Provide appropriate anesthetic care for the range of neuroradiologic procedures, including endovascular therapy of stroke,
693 cerebral aneurysm, vasospasm, vertebroplasty and stereotactic biopsies, and arteriovenous malformation and for
694 diagnostic procedures include angiography, CT scan, and MRI.

695 **3. Medical Knowledge**

696

697 At the conclusion of this rotation the fellow must demonstrate advanced knowledge of:

- 698 **a.** Principles of brain imaging with fluoroscopy, CT and MRI.
- 699 **b.** Cerebrovascular anatomy and pathophysiology as it applies to interventional neuroradiology.
- 700 **c.** Identification of mass effect, midline shift, effacement of sulci/gyri, loss of gray-white differentiation as signs of increased
701 ICP.
- 702 **d.** Differentiation of subdural and epidural hematoma.
- 703 **e.** Differentiation of hemorrhagic and ischemic stroke.
- 704 **f.** Grading scales for subarachnoid hemorrhage, arteriovenous malformation, and angiographic flow after endovascular
705 therapy of ischemic stroke.
- 706 **g.** Identification of unstable or immobile cervical spine.
- 707 **h.** Recognition of complications (e.g., intra-procedural cerebral hemorrhage, vessel thrombosis, and extra cranial arterial
708 rupture/hemorrhage) and their treatment during interventional procedures.

709

710 Understanding of issues in anesthesia for neuroradiologic procedures, including endovascular therapy of stroke, cerebral aneurysm, vasospasm,
711 and arteriovenous malformation.

712

713

714 **c. Critical Care of the Neurologic Patient (≥ 1 four-week module)**

715

716 **1. Curriculum**

717

718 During these rotation fellows will manage critically ill patients with a focus on neurological or neurosurgical problems. The fellows will
719 experience care of patients who are admitted from the emergency department or transported from an outside medical facility for preoperative
720 evaluation and preparation. They will also be exposed to patients admitted to the intensive care unit postoperatively, thus experiencing the

721 postoperative care of neurosurgical patients. The fellows will participate in clinical and teaching rounds with the neurosurgical and/or intensive
722 care unit (NICU) attending. Fellows will conduct a history and physical examination and actively manage the care of these patients. This
723 management should include (1) placement, data interpretation, and management of invasive lines, (2) tracheal intubations and other forms of
724 airway management, (3) monitoring of ICP and cerebral perfusion pressure, and (4) understanding the role of multimodal intracranial monitoring
725 (even if not locally employed). Fellows will be actively involved in writing orders for these patients under the supervision of the NICU attending.
726 Fellows will also manage issues arising from the underlying neurologic condition, such as intracranial hypertension, cerebral vasospasm, and the
727 systemic complications of brain injury (including cardiorespiratory, electrolyte, coagulation, and endocrine problems), as well as other common
728 ICU problems including sepsis, systemic shock, and multiple organ failure.

729 **2. Competencies & patient care**

730
731 At the conclusion of this rotation the fellow must be able to:

- 732 **a.** Manage intracranial hypertension in the critically ill patient.
- 733 **b.** Manage patients with traumatic brain injury based on established guidelines.
- 734 **c.** Manage patients with ischemic or hemorrhagic stroke.
- 735 **d.** Manage postoperative neurosurgical patients in preparation for transfer to a regular nursing floor or step-down unit.
- 736 **e.** Admit patients with history of critical neurological or neurosurgical problems, appreciate the emergent need for
737 neurosurgical or endovascular intervention, and be involved in physiologic optimization of these patients.
- 738 **f.** Evaluate tracheally-intubated patients for weaning and preparing for extubation.
- 739 **g.** Manage ventriculostomies and spinal drains.
- 740 **h.** Manage patients with cerebral vasospasm.
- 741 **i.** Diagnose brain death based on regionally established guidelines.
- 742 **j.** Manage central nervous system infections.

- 743 **k.** Evaluate and treat perioperative pneumonia and other systemic infections
- 744 **l.** Manage common electrolyte and endocrine abnormalities in the neurologically ill patient.
- 745 **m.** Manage cardiorespiratory complications of neurologic injury.
- 746 **n.** Evaluate and manage postoperative pain and implement analgesic regimens tailored to the limitations imposed by the
747 patient's neurological status.
- 748 **o.** Actively be involved in multidisciplinary consultations and implementation of recommendations from consulting service.
- 749 **p.** Actively be involved in family meetings and discussions of end-of-life care.
- 750 **q.** Manage patients with electrophysiological monitoring (EEG)
- 751 **r.** Manage seizures and status epilepticus

752 **3. Medical Knowledge**

753

754 At the conclusion of this rotation the fellow must demonstrate advanced knowledge of:

- 755 **a.** Interpretation of hemodynamic and respiratory data in the NICU.
- 756 **b.** Interpretation of multimodal intracranial monitoring data and their application to guide individualized therapy.
- 757 **c.** Hemodynamic effects and mechanisms of inotropic agents.
- 758 **d.** Sensory and motor innervation and neurologic exam.
- 759 **e.** Grading of patients with subarachnoid hemorrhage (SAH).
- 760 **f.** Identification and management of hemodynamic changes after SAH and AVM.
- 761 **g.** Complications of SAH and AVM and their management.
- 762 **h.** Hemodynamic goals in postoperative patients with intracranial vascular abnormalities.
- 763 **i.** Management principles of ischemic stroke, including the need for timely intervention.
- 764 **j.** Diagnosis and management of cardiac abnormalities including ischemic changes and acquired cardiomyopathy in NICU
765 patients.

- 766 **k.** Management of cardiac arrhythmias.
- 767 **l.** Use of hyperosmolar therapy to treat intracranial hypertension and/or systemic shock.
- 768 **m.** Use of –targeted temperature management
- 769 **n.** Pharmacologic methods of brain protection.
- 770 **o.** Postoperative sepsis and pneumonia.
- 771 **p.** Mechanical ventilation modes and its implications for patients with neurological diseases.
- 772 **q.** Bioethics and end-of-life decisions; diagnostic criteria for brain death.
- 773 **r.** Sedation and pain management in the ICU.
- 774 **s.** Advanced cardiac life support and resuscitation.
- 775 **t.** Diagnostic criteria for brain death.

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d. Intraoperative Neuromonitoring (>1 four-week module or adequate experience during neuroanesthesia modules)

780 **1. Curriculum**

781
782 Intraoperative neuromonitoring is frequently used to guide surgical procedures and potentially avoid surgical complications. In some centers the
783 neuroanesthesiologist is responsible for monitoring and interpreting the electroencephalogram (EEG) and evoked potentials. In other centers a
784 neuromonitoring technician performs the recording and a neurologist or neurophysiologist interprets the finding. Adequate knowledge of the
785 principles of evoked potential monitoring is essential in the anesthetic management of neurosurgical patients. Evoked potential monitoring
786 includes somatosensory-evoked potentials (SSEP), motor-evoked potentials (MEP), or electromyography (EMG) (or their combination), which are
787 oftentimes also performed in complex surgical procedures on the spine. Brainstem auditory evoked potentials can also be used for brain
788 monitoring during intracranial surgery. Intracranial surgical procedures are commonly performed to identify and excise epileptogenic foci in the
789 brain. In some instances, there is a need for intraoperative EEG monitoring or electrocorticography, which is especially important during brain

790 mapping. However, intraoperative EEG is also performed during vascular surgeries including, but not limited to carotid endarterectomy during
791 which EEG wave form changes are monitored in order to confirm adequacy of intracranial blood flow. Other neuromonitoring modalities include
792 ICP monitoring, transcranial Doppler sonography, cerebral oximetry and PbO₂, and processed EEG techniques.

793 **2. Competencies & patient care**

794
795 At the conclusion of this rotation, fellow will be competent to evaluate the neuromonitoring data and understand the indications and interactions
796 with anesthesia of:

- 797 **a.** EEG, Processed and unprocessed
- 798 **b.** Evoked Potentials, brainstem auditory, somatosensory, motor
- 799 **c.** Electromyography

800
801 At the conclusion of this rotation (or fellowship-long embedded experience) the fellow must be able to:

- 802 **a.** Understand the indications and limitations of neuromonitoring.
- 803 **b.** Identify patients who might benefit from neuromonitoring.
- 804 **c.** Describe the appropriate neuromonitoring for the planned procedure.
- 805 **d.** Identify complications associated with placement of neuromonitoring.
- 806 **e.** Recognize interference caused by some neurophysiologic methods on hemodynamic monitors.
- 807 **f.** Manage the impact of anesthetic technique on neurophysiologic neuromonitoring.
- 808 **g.** Respond appropriately to changes in evoked potentials.
- 809 **h.** Manage neuromuscular blockade and associated anesthetics appropriately in cases with MEP or electromyography.
- 810 **i.** Identify changes in neuromonitoring and list a differential diagnosis to determine causes of such adverse changes.
- 811 **j.** Realize potential complications and implications for anesthetic management in the placement of EEG grids or in patients
812 who have a second anesthetic with the grids already in place.
- 813 **k.** Manage intraoperative seizures detected by EEG monitoring.
- 814 **l.** Use and interpret cerebral oximetry

- 815 **m.** Interpret the results of transcranial Doppler-sonography studies.
816 **n.** Identify indications for various methods of ICP monitoring.
817 **o.** Identify potential applications of EEG to assess depth of anesthesia

818

819 **3. Medical Knowledge**

820

821 At the conclusion of this rotation the fellow must have acquired advanced knowledge of:

- 822 **a.** Rational monitoring choices for complex spine surgery, intracranial cerebrovascular surgery, and carotid endarterectomy.
823 **b.** Principles of electroencephalography.
824 **c.** Electroencephalographic changes with medications or anesthetics.
825 **d.** Neural pathways involved in the generation of sensory- and motor-evoked potentials.
826 **e.** Indications and physiologic basis for spontaneous and triggered electromyography.
827 **f.** Differential changes in latency and amplitude of neuromonitoring wave forms with different anesthetics.
828 **g.** Effects of ischemic changes on neuromonitoring.
829 **h.** Effect of surgical manipulation on neuromonitoring.
830 **i.** Anesthetic considerations and surgical complications of EEG grid placement.
831 **j.** Complications of neuromonitoring.
832 **k.** Principles of near-infrared spectroscopy.
833 **l.** Decision making based on PbO₂ and microdialysis monitoring
834 **m.** Understand principles and controversies in use of processed EEG to assess depth of anesthesia

835

836

- 837 **b.** **Clinical Neuroscience Scholarship (≥1 four-week module or significant experience concurrently during neuroanesthesiology**
838 **modules**

839

840 **1. Curriculum**

841
842 This module requires mentoring of the fellow by an attending faculty with experience in scholarly projects in the field of neuroscience. The mentor
843 need not be a neuroanesthesiologist and the level of support and advice will depend on fellow's experience. The module can involve 1) designing
844 and conducting a clinical investigation or quality improvement initiative related to neuroanesthesiology, neurocritical care, or a related discipline,
845 2) preparation of a review article, book chapter, case report/series, or a database project, 3) preparation and presentation of lecture(s), journal
846 clubs, or seminar(s) with concurrent provision of improvements in local educational resources(e.g. bibliography review, teaching materials,
847 videos, pod casts, web pages, simulation scenarios, etc.) relevant to neuroanesthesiology. It is expected that the fellow will gain experience in
848 oral presentation skills and submit written work for publication as appropriate. This module should likely be planned and initiated early in the
849 year, so that the fellow has adequate time to pursue the academic project. Alternatively, the project may be developed early in the fellowship and
850 the research/academic time can be distributed or allotted as needed to accomplish the project. It is expected that substantial basic or translational
851 neuroscience projects will require a second year of fellowship/postdoctoral training. It is desirable that the fellows present their scholarly projects
852 at the annual meeting of SNACC or other regional or international scientific meetings or interest groups with neuroscientific focus or component.

853 **2. Competencies & patient care**

854
855 At the conclusion of this rotation the fellow should be able to:

- 856 **a.** Utilize the information gathered through a research or quality improvement project, or preparation of a case report or
857 review article, to improve patient care.
- 858 **b.** Understand the basic Institutional Review Board regulations and approval process in regard to patient care and patient
859 advocacy.
- 860 **c.** Demonstrate knowledge of the principles of ethical and responsible conduct of research and quality improvement.

861 Synthesize research and/or QI data, and literature review, into written and/or oral summaries

862

863 **3. Medical Knowledge**

864

865 At the conclusion of this rotation the fellow must have acquired advanced knowledge of:

- 866 **a.** Literature search methodology
867 **b.** Critical review of published studies.
868 **c.** Basic study design.
869 **d.** Basic statistical methods.
870 **e.** Preparation of a manuscript or oral summary.
871 **f.** Ethical principles of clinical investigation and quality improvement.
872 **g.** Role of the Institutional Review Board in the approval of studies and maintenance of ethical standards.
873 **h.** Advanced educational techniques including simulation and advanced audio-visual methods

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c. Pediatric Neuroanesthesia (elective rotation)

878 **1. Curriculum**

879 Fellows who desire experience in the clinical care of pediatric neurosurgical patients can be offered an elective rotation focused on pediatric
880 neuroanesthesiology. This module would be a rotation during which the fellows will be involved in perioperative and anesthetic care of pediatric
881 patients undergoing neurosurgical procedures including intracranial, spine, peripheral nervous system, and interventional neuroradiology. The
882 duration and number of modules are as defined by the program director but without interfering with the global educational goals of a
883 neuroanesthesiology fellowship. Notably, some practices include pediatric patients in a general neuroanesthesia practice and similarly such
884 experience confers the same goals as a modular pediatric experience but also without interfering with the global educational goals of a
885 neuroanesthesiology fellowship. Moreover, an independent experience in a ICPNT-sanctioned pediatric neuroanesthesiology module cannot be
886 construed as having participated in an accredited pediatric anesthesiology fellowship unless a cooperative arrangement between pediatric and
887 neuroanesthesiology fellowship exists.

888 Intracranial procedures will include all procedures similar to those applied to adults, but with more emphasis on the treatment of diseases affecting
889 the pediatric population. Involvement of the central nervous system is frequently seen in pediatric patients with genetic and metabolic dysfunction.
890 These patients have specific anesthetic challenges including (1) airway issues, (2) hydrocephalus, (3) malignancy with massive hemorrhage, (4)

891 anomalies of the cardiac, genitourinary and pulmonary systems, (5) craniosynostosis, and (6) specific limitations in the anesthetic agents that may
892 be used. Spine cases in the pediatric population include corrective procedures with instrumentation that may involve ventilation challenges related
893 to restrictive lung disease. Shunt placements are also an important part of pediatric neurosurgery. The fellows should also participate in the
894 educational conferences in the pediatric anesthesia group including problem-based discussions, resident presentations and journal clubs.

895 **2. Competencies & patient care**

896 At the conclusion of this rotation fellows will be competent to administer anesthesia for pediatric patients undergoing

897

- 898 **a.** Craniotomy for tumor (supra- and infra-tentorial)
- 899 **b.** Craniotomy for intracranial vascular pathology
- 900 **c.** Ventricular cerebrospinal fluid diversion (peritoneal, atrial, pleural)
- 901 **d.** Diagnostic and interventional radiology procedures
- 902 **e.** Complex spinal and vertebral surgery
- 903 **f.** Craniosynostosis repair

904

905 At the conclusion of this rotation the fellow should be able to:

- 906 **a.** Perform preoperative evaluation in patients with information gathered from previous history, history obtained from adults
907 accompanying the pediatric patient, physical examination, and laboratory data.
- 908 **b.** Provide appropriate airway support and perform difficult intubations commonly seen in these patients.
- 909 **c.** Provide measures to decrease preoperative anxiety in these patients without jeopardizing mental status, oxygenation, or
910 ventilation.
- 911 **d.** Differentiate methods of inserting invasive monitoring lines in the pediatric age group.

912 e. Implement knowledge acquired during rotations in adult neurosurgical anesthesiology regarding hemodynamic
913 monitoring, transport, intraoperative monitoring, pharmacologic effects of antiepileptic medications, and understand the
914 differences in each for the pediatric population.

915

916 **3. Medical Knowledge**

917

918 At the conclusion of this rotation the fellow must demonstrate advanced synthetic knowledge of:

919 a. Basic anatomic and physiologic differences in the central and peripheral nervous system between adult and pediatric
920 patients.

921 b. Pharmacologic effects of anesthetic and antiepileptic medications in pediatric patients.

922 c. Neurologic manifestations of metabolic and genetic syndromes and their implications for anesthetic management.

923 d. Indications, contraindications, and possible complications of invasive monitoring in pediatric patients.

924 e. Age- and pathology-dependent hemodynamic goals for adequate cerebral perfusion in pediatric patients.

925 f. Maintenance of adequate perfusion in spine procedures.

926 g. Management of increased ICP in pediatric patients.

927 h. Identification of disorders and conditions with a higher rate of uncommon but life-threatening anesthetic complications in
928 the pediatric population such as latex allergy and malignant hyperthermia.

929 i. Issues in neonatal and pediatric anesthetic and perioperative neurotoxicity

930

931

932 **B. Fellow Duty Hours and Working Environment**

933

934 **1. Professionalism, Personal Responsibility, and Patient safety**

935 The program director and sponsoring institution must ensure a culture of professionalism that supports patient safety and
936 personal responsibility. Programs and sponsoring institutions must educate fellows and faculty members concerning the

937 professional responsibilities of physicians to appear for duty appropriately rested and fit to provide the services required
938 by their patients.

939

940 **2. The learning objective of the program must:**

941 **a.** Be accomplished through an appropriate blend of supervised patient care responsibilities, clinical teaching, and didactic
942 educational events; and,

943 **b.** Not be compromised by excessive reliance on fellows to fulfill non-physician service obligations

944 **3. Supervision of Fellows**

945 **a.** In the clinical learning environment, each patient must have an identifiable, appropriately-credentialed and privileged
946 attending physician (or licensed independent practitioner as approved by each institution) who is ultimately responsible
947 for that patient's care.

948 **1.** This information should be available to fellows, faculty members, and patients.

949 **2.** Fellows and faculty members should inform patients of their respective roles in each patient's care.

950 **b.** The program must ensure that the appropriate level of supervision is in place for all fellows who care for patients.

951 **c.** Supervision may be exercised through a variety of graduated methods and consistent with the local laws and regulations.
952 Some activities require the physical presence of the supervising faculty member. For many aspects of patient care, the
953 supervising physician may be a more advanced fellow. Other portions of care provided by the fellow can be adequately
954 supervised by the immediate availability (rather than presence) of the supervising faculty member, either in the institution,
955 or by means of telephonic and/or electronic modalities according to local regulations. In some circumstances, supervision
956 may include post-hoc review of fellow-delivered care with feedback as to the appropriateness of that care.

- 957 **d.** Levels of Supervision
- 958 **1.** To ensure oversight of fellow supervision and graded authority and responsibility, the program must use the
- 959 following classification of supervision by core faculty:
- 960 (i) Direct Supervision – the supervising physician is physically present with the fellow and patient.
- 961 (ii) Indirect Supervision:
- 962 • With direct supervision immediately available – the supervising physician is physically
- 963 within the hospital or another site of patient care, and is immediately available to provide
- 964 Direct Supervision and/or consultation.
- 965 • With direct supervision available – the supervising physician is not necessarily physically
- 966 present within the hospital or other site of patient care, but is immediately available by
- 967 means of telephonic and/or electronic modalities, and is available to provide consultation
- 968 and/or Direct Supervision.
- 969 • Depending on institutional rules and funding mechanisms indirect supervision may entail
- 970 the fellow having an appointment as an instructor or junior faculty. Fellows can be
- 971 allowed to function as junior faculty, as allowed by institutional guidelines and local laws
- 972 and regulations, and still be indirectly supervised by core faculty consultants with
- 973 advancement to this capacity as the fellow shows satisfactory improvement during the
- 974 training program
- 975 (iii) Oversight – The supervising physician is available to provide review of procedures/encounters with
- 976 feedback provided after care is delivered.
- 977 **2.** The privilege of progressive authority and responsibility, conditional independence, and a supervisory role in
- 978 patient care delegated to each fellow must be assigned by the program director and faculty members.
- 979 **3.** The program director must evaluate each fellow’s abilities based on achievement of competencies described in
- 980 this document.

- 1005 regional or institutional educational authority. In the absence of such rules the program should have its own rules
1006 in place balancing priorities related to optimal patient care and optimal educational experience.
- 1007 2. Maximum duration of an individual shift, rest period between shifts, maximal frequency of in-house call and in-
1008 house night flight, and amount of call from home, should be delineated on the application for accreditation
1009 according to rules promulgated by the relevant regional or institutional educational authority. In the absence of
1010 such rules the program should have its own rules in place.
- 1011 3. In unusual circumstances, fellows, on their own initiative, may remain beyond their scheduled period of duty to
1012 continue to provide care to a single patient. Justifications for such extensions of duty are limited to reasons of
1013 required continuity for a severely ill or unstable patient, academic importance of the events transpiring, or
1014 humanistic attention to the needs of a patient or family.
- 1015 4. Moonlighting defined as unsupervised practice should not be counted towards the training and must not interfere
1016 with the ability of the fellow to achieve the goals and objectives of the educational program.

1019 **C. Evaluation**

1021 **1. Fellow Evaluation**

1022 **a. Formative Evaluation for education purposes**

- 1023 1. The faculty must evaluate fellow performance in a timely manner
- 1024 2. The faculty must provide evaluations of each fellow's progress and competency to the program director after each
1025 rotation and when requested by the program director.
- 1026 3. The program must:
- 1027 (i) Provide objective assessments of competence in patient care and medical knowledge according to the
1028 academic guidelines of the institution
- 1029 (ii) Use multiple evaluators (e.g., faculty, peers, patients, self, and other professional staff); and,

- 1030 (iii) Provide each fellow with documented evaluation of performance with feedback at least
1031 semiannually.
- 1032 (iv) Provide each fellow with feedback evaluation at the end of each rotation
- 1033 4. The evaluations of fellow performance must be accessible for review by the fellow, in accordance with
1034 institutional policy.
- 1035 5. Disciplinary and remedial actions
- 1036 (i) Fellows who violate local rules and expectations regarding behavior or professionalism should be
1037 subject to disciplinary actions in accordance with local institutional policy
- 1038 (ii) Fellows who are progressing poorly in terms of achieving competency goals of the fellowship, at
1039 the discretion of the program director may be subject to remedial action which may include slowing the
1040 rate of increasing responsibility, repeating rotations, increasing duration of the fellowship, attending
1041 additional conferences or lectures, participating in simulation activities, or other constructive endeavors.
- 1042 (iii) The frame for any educational program is the future patients who will be under the care of the
1043 trainee. Based on this frame, there should thus be no reluctance to discharge a poorly performing trainee
1044 who is deemed to be unlikely to achieve the goals of the fellowship.

1045

1046 **b. Summative Evaluation.**

1047 The program director must provide a summative evaluation for each fellow upon completion of the program. This evaluation may
1048 include a summary of monthly evaluations or an oral and/or written examination consistent with institutional academic guidelines
1049 and must become part of the fellow's permanent record maintained by the institution and be accessible for review by the fellow in
1050 accordance with institutional policy. This evaluation must:

1051

- 1052 1. Document the fellow's performance during the final period of education, and
- 1053 2. Verify that the fellow has demonstrated sufficient competence to enter advanced and independent

1054 neuroanesthesiology practice after completion of required anesthesiology training.

1055 3. Summarize the case experience (based on ICPNT definition of case credits) of each fellow during their
1056 fellowship.

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1058 **2. Faculty Evaluation**

1059 a. At least annually, the program must incorporate faculty performance evaluation as it relates to the educational program.

1060 b. These evaluations should include a review of the faculty's clinical teaching abilities, commitment to the educational
1061 program, clinical knowledge, professionalism, and scholarly activities.

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1063 **3. Program Evaluation and Improvement**

1064 a. The program director must document formal, systematic evaluation of the curriculum at least annually. The program must
1065 monitor and track each of the following areas:

1066 1. Fellow performance;

1067 2. Faculty development

1068 b. If deficiencies are found, the program should prepare a written plan of action to document initiatives to improve
1069 performance. The action plan should be reviewed and approved by the teaching faculty and documented in meeting
1070 minutes.

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