

## *Core Curriculum and Core Competencies in Neurological Intensive Care*

*(Note: this document has not been adopted by the United Council for Neurologic Subspecialties and is currently under review: January 2006)*

These guidelines regarding the program content of advanced training in neurological intensive care are based on criteria developed for advanced training in critical care medicine by the Society of Critical Care Medicine (SCCM). These guidelines have been reviewed and adapted to ensure that they combine basic aspects of general critical care medicine that are relevant to neurocritical care, as well as specialized skills that are specific to neurocritical care. The following is a listing of cognitive and procedural skills that are fundamental to the training of specialists in neurocritical care, regardless of whether a training program is based in neurology, neurosurgery, internal medicine, anesthesiology, pediatrics, or another specialty. This list also includes pertinent aspects on general critical care, such as cardiac, pulmonary, and infectious disease management.

Program directors may choose to include additional cognitive or procedural skills to augment this listing in order to suit their goals for advanced training for physicians in neurocritical care. These guidelines should be used as recommendations for training directors to use in the development of each program. They are not intended to constrain any training program. They provide the basic framework for future mandates of cognitive and procedural skills necessary for a training program. Each director determines the content of his or her program.

### **A. COGNITIVE SKILL SET**

Acquisition of the following cognitive skills by trainees can be accomplished through the use of any of a number of techniques, including supervised direct patient care, didactic sessions, journal clubs, or literature reviews.

#### **I. NEUROLOGICAL DISEASE STATES: PATHOLOGY, PATHOPHYSIOLOGY AND THERAPY**

The following are specific diseases, conditions, and clinical syndromes commonly managed by a neurointensivist:

##### **A. *Cerebrovascular Diseases***

1. Infarction and ischemia
  - a. Massive hemispheric infarction
  - b. Basilar artery occlusion and stenosis
  - c. Carotid artery occlusion and stenosis
  - d. Crescendo TIAs
  - e. Occlusive vasculopathies (Moya-Moya, sickle cell)
  - f. Spinal cord infarction
2. Intracerebral hemorrhage
  - a. Supratentorial
  - b. Cerebellar

- c. Brainstem
- d. Intraventricular
- 3. Subarachnoid hemorrhage – aneurysmal and other
- 4. Vascular malformations
  - a. Arteriovenous malformations
  - b. AV fistulas
  - c. Cavernous angiomas
  - d. Venous angiomas
- 5. Dural sinus thrombosis
- 6. Carotid-cavernous fistulae
- 7. Cervical and cerebral arterial dissections

**B. Neurotrauma**

- 1. Traumatic Brain injury
  - a. Axonal shearing injury
  - b. Epidural hematoma
  - c. Subdural hematoma
  - d. Skull fracture
  - e. Contusions and lacerations
  - f. Penetrating craniocerebral injuries
  - g. Traumatic subarachnoid hemorrhage
- 2. Spinal cord injury
  - a. Traumatic injury (transection, contusion, concussion)
  - b. Vertebral fracture and ligamentous instability
- 3. Electrical injury (e.g. lightning)

**C. Seizures and Epilepsy**

- 1. Status epilepticus
  - a. Convulsive
  - b. Non-convulsive (partial-complex and “subtle” secondarily generalized SE)
  - c. Myoclonic

**D. Neuromuscular Diseases**

- 1. Myasthenia gravis
- 2. Guillain-Barre syndrome
- 3. ALS
- 4. Rhabdomyolysis and toxic myopathies
- 5. Critical illness myopathy and neuropathy

**E. Infections**

- 1. Encephalitis (viral, bacterial, parasitic)
- 2. Meningitis (viral, bacterial, parasitic)
- 3. Brain and spinal epidural abscess
- 4. Tetanus
- 5. Botulism

**F. Neuro-oncology**

1. Brain tumors and metastases
2. Spinal cord tumors and metastases
3. Carcinomatous meningitis
4. Paraneoplastic syndromes

**G. Toxic-metabolic Disorders**

1. Neuroleptic malignant syndrome/malignant hyperthermia
2. Serotonin syndrome
3. Drug overdose and withdrawal (e.g., barbiturates, narcotics, alcohol, cocaine, acetaminophen).
4. Temperature related injuries (hyperthermia, hypothermia)

**H. Inflammatory and Demyelinating Diseases**

1. Multiple sclerosis (Marburg variant, transverse myelitis)
2. Neurosarcoidosis
3. Acute disseminated encephalomyelitis (ADEM)
4. CNS vasculitis
5. Chemical or sterile meningitis (i.e. posterior fossa syndrome, NSAID induced)
6. Central pontine myelinolysis
7. Others

**I. Encephalopathies**

1. Eclampsia, including HELLP Syndrome
2. Hypertensive encephalopathy and Posterior Reversible Encephalopathy Syndrome (PRES)
3. Hepatic encephalopathy
4. Uremic encephalopathy
5. Hypoxic-ischemic and anoxic encephalopathy
6. MELAS and related disorders

**J. Neuroendocrine Disorders**

1. Pituitary Apoplexy
2. Diabetes insipidus (including triple phase response)
3. Panhypopituitarism

**K. Movement Disorders**

1. Severe dystonia and opisthotonus
2. Hemiballismus
3. Acute dystonic reactions

**L. Clinical syndromes**

1. Coma
2. Herniation syndromes
3. Elevated intracranial pressure
4. Intracranial hypotension/hypovolemia
5. Hydrocephalus
6. Cord compression
9. Brain death
8. Vegetative state
10. Delirium
11. Abulia
12. Dysautonomia (central fever, hyperventilation, etcetera)
13. Reversible posterior leukoencephalopathy syndrome
14. Psychiatric emergencies

**M. Perioperative Neurosurgical Care**

1. Post-craniotomy hypertension
2. Post-craniotomy pain
3. Wound CSF leaks
4. Post-craniotomy CSF hypovolemia
5. Wound infections
6. Post-operative brain edema
7. Post-craniotomy intracranial hemorrhage
8. Post-carotid endarterectomy/stenting hyperperfusion syndrome
9. Post-cervical spine surgery airway management

**N. Neurorehabilitation****O. Pharmacotherapeutics****II. GENERAL MEDICAL DISEASE STATES: PATHOLOGY, PATHOPHYSIOLOGY AND THERAPY**

The following are medical conditions and skill requirements often encountered by neurointensivists

**A. Cardiovascular Physiology, Pathology, Pathophysiology, and Therapy**

1. Shock (hypotension) and its complications (vasodilatory and cardiogenic)
2. Myocardial infarction and unstable coronary syndromes
3. Neurogenic cardiac disturbances (ECG changes, stunned myocardium)
4. Cardiac rhythm and conduction disturbances; use of antiarrhythmic medications; indications for and types of pacemakers
5. Pulmonary embolism
6. Pulmonary edema: cardiogenic versus noncardiogenic (including neurogenic)
7. Acute aortic and peripheral vascular disorders (i.e. dissection, pseudoaneurysm)

8. Recognition, evaluation and management of hypertensive emergencies and urgencies
9. Calculation of derived cardiovascular parameters, including systemic and pulmonary vascular resistance, alveolar-arterial gradients, oxygen transport and consumption

**B. *Respiratory Physiology, Pathology, Pathophysiology and Therapy***

1. Acute respiratory failure
  - a. Hypoxemic respiratory failure (including ARDS)
  - b. Hypercapnic respiratory failure
2. Aspiration
3. Bronchopulmonary infections
4. Upper airway obstruction
5. COPD and status asthmaticus, including bronchodilator therapy
6. Neurogenic breathing patterns (central hyperventilation, Cheyne-Stokes respirations, etc)
7. Mechanical ventilation
  - a. Positive pressure ventilation (including endotracheal intubation and noninvasive positive pressure ventilation [NPPV])
  - b. Currently available ventilator modes: SIMV, CMV, CPAP, inverse ratio ventilation, pressure support ventilation, pressure control ventilation.
  - c. Negative pressure ventilation
  - d. Barotrauma, airway pressures (including permissive hypercapnia)
  - e. Criteria for weaning and weaning techniques
8. Pleural Diseases
  - a. Empyema
  - b. Massive effusion
  - c. Pneumothorax
9. Pulmonary hemorrhage and massive hemoptysis
10. Chest X-ray interpretation
11. End tidal CO<sub>2</sub> monitoring
12. Sleep apnea
13. Control of breathing

**C. *Renal Physiology, Pathology, Pathophysiology and Therapy***

1. Renal regulation of fluid and water balance and electrolytes
2. Renal failure: Prerenal, renal, and postrenal
3. Derangements secondary to alterations in osmolality and electrolytes
4. Acid-base disorders and their management
5. Principles of hemodialysis
6. Evaluation of oliguria and polyuria
7. Drug dosing in renal failure
8. Management of rhabdomyolysis
9. Neurogenic disorders of sodium and water regulation (cerebral salt wasting and SIADH).

**D. *Metabolic and Endocrine Effects of Critical Illness***

1. Enteral and parenteral nutrition
2. Endocrinology
  - a. Disorders of thyroid function (thyroid storm, myxedema coma, sick euthyroid syndrome)

- b. Adrenal crisis
- c. Diabetes mellitus
  - 1) Ketotic and hyperglycemic hyperosmolar coma
  - 2) Hypoglycemia
- d. Pheochromocytoma
- e. Disorders of calcium and magnesium balance
- 2. Systemic Inflammatory Response Syndrome (SIRS)
- 3. Fever, thermoregulation, and cooling techniques

**E. *Infectious Disease Physiology, Pathology, Pathophysiology and Therapy***

- 1. Antibiotics
  - a. Antibacterial agents
  - b. Antifungal agents
  - c. Antituberculosis agents
  - d. Antiviral agents
  - e. Antiparasitic agents
- 2. Infection control for special care units
  - a. Development of antibiotic resistance
  - b. Universal precautions
  - c. Isolation and reverse isolation
- 3. Hospital acquired and opportunistic infections in the critically ill
- 4. HIV/AIDS
- 5. Evaluation of fever in the ICU patient
- 6. Central fever
- 7. Interpretation of antibiotic concentrations, sensitivities

**F. *Physiology, Pathology, Pathophysiology and therapy of Acute Hematologic Disorders***

- 1. Acute defects in hemostasis
  - a. Thrombocytopenia, thrombocytopathy
  - b. Disseminated intravascular coagulation
  - c. Acute hemorrhage (e.g., GI hemorrhage, retroperitoneal hematoma)
- 2. Anticoagulation and fibrinolytic therapy
- 3. Principles of blood component therapy (blood, platelets, FFP)
- 4. Hemostatic therapy (e.g., vitamin K, aminocaproic acid, protamine, factor VIIa)
- 5. Acute hemolytic disorders including thrombotic microangiopathies, TTP
- 6. Prophylaxis against thromboembolic disease
- 8. Hypercoagulable states

**G. *Physiology, Pathology, Pathophysiology and Therapy of Acute Gastrointestinal (GI) and Genitourinary (GU) Disorders***

- 1. Upper and lower gastrointestinal bleeding
- 2. Acute and fulminant hepatic failure (including drug dosing)
- 3. Ileus and toxic megacolon
- 4. Acute perforations of the gastrointestinal tract
- 4. Acute vascular disorders of the intestine, including mesenteric infarction
- 5. Acute intestinal obstruction, volvulus
- 6. Pancreatitis
- 7. Obstructive uropathy, acute urinary retention
- 8. Urinary tract bleeding

## **H. Immunology and Transplantation**

1. Principles of transplantation (brain death, organ donation, procurement, maintenance of organ donors, implantation).
2. Immunosuppression, especially the neurotoxicity of these agents

## **I. General Trauma and Burns**

1. Initial approach to the management of multisystem trauma
2. Skeletal trauma including the spine and pelvis
3. Chest and abdominal trauma - blunt and penetrating
4. Burns and electrical injury

## **III. GENERAL ASPECTS OF CRITICAL CARE**

### **A. Monitoring**

1. Neuromonitoring
2. Prognostic, disease severity and therapeutic intervention scores (i.e. APACHE)
3. Principles of electrocardiographic monitoring
4. Invasive hemodynamic monitoring
5. Noninvasive hemodynamic monitoring
6. Respiratory monitoring (airway pressure, intrathoracic pressure, tidal volume, pulse oximetry, dead space, compliance, resistance, capnography)
7. Metabolic monitoring (oxygen consumption, carbon dioxide production, respiratory quotient)
8. Use of computers in critical care units for multimodality monitoring

### **B. Administrative and Management Principles and Techniques**

1. Organization and staffing of critical care units
2. Standards for special care units, Joint Commission on Accreditation of Healthcare Organizations
3. Collaborative practice principles, including multidisciplinary rounds and management
4. Emergency medical systems in prehospital care
5. Performance improvement, principles and practices, QA
6. Principles of triage and resource allocation, bed management
7. Post-hospital care and discharge planning
8. Medical economics: health care reimbursement, budget development

### **C. Ethical and Legal Aspects of Critical Care Medicine**

1. Death and dying
2. Forgoing life-sustaining treatment and orders not to resuscitate
3. Rights of patients, the right to refuse treatment
4. Living wills, advance directives; durable power of attorney
5. Terminal extubation and palliative care
6. Rationing and cost containment
7. Emotional management of patients, families and caregivers.

#### **D. Principles of Research in Critical Care**

1. Study design
2. Biostatistics
3. Grant funding and protocol writing
4. Manuscript preparation
5. Presentation preparation and skills
6. Institutional Review Boards and HIPAA

### **B. PROCEDURAL COMPETENCIES**

All are not required, but all are reasonable to include in a neurocritical care advanced training program. Asterisk indicates procedures to be performed under direct visual supervision by qualified personnel until competency is established. The definition of competency to perform the listed procedures must include knowledge of the indications, contraindications, complications and their treatment, and technical performance of each of these interventions. Advanced procedures are reasonable to offer in selected cases if qualified personnel provide instruction.

#### **1. General Critical Care (essential for neurointensive care trainees)**

- a. Peripheral venous line placement
- b. Arterial puncture
- c. Arterial catheter placement
- d. Naso-/oro- gastric/duodenal tube insertion
- e. Central venous catheter placement
- f. Pulmonary artery catheterization
- g. Management of mechanical ventilation, including CPAP/BiPAP ventilation
- h. Administration of vasoactive medications (hemodynamic augmentation and hypertension lysis)
- i. CPR and ACLS (with certification)
- j. Maintenance airway and ventilation in nonintubated, unconscious patients
- k. Interpretation and performance of bedside pulmonary function tests
- l. Direct laryngoscopy
- m. Endotracheal intubation

#### **2. Advanced General Critical Care (generally considered optional for neurointensivists)**

- a. Administration of nitric oxide or prostacyclin
- b. Hemodialysis, including PD, CVVH, and CVVHD
- c. Fiberoptic bronchoscopy
- d. Echocardiography
- e. Tracheostomy
- f. Percutaneous gastrostomy
- g. Diagnostic pleurocentesis, chest tube insertion, drainage systems
- h. Vascath/dialysis catheter placement
- i. Abdominal paracentesis
- j. ECMO and other circulatory support systems (IABP, LVAD, etc)

#### **3. Neurocritical Care (essential for neurointensivists)**

- a. Lumbar puncture

- b. Shunt and ventricular drain tap for CSF sampling
- c. Performance and interpretation of transcranial Doppler
- d. Administration of analgesedative medications, including conscious sedation and barbiturate anesthesia
- e. Interpretation of continuous EEG monitoring
- f. Interpretation and management of ICP and CPP data
- g. Jugular venous bulb catheterization
- h. Interpretation of S<sub>ijv</sub>O<sub>2</sub> and P<sub>bt</sub>O<sub>2</sub> data
- i. Management of external ventricular drains
- j. Management of plasmapheresis and IVIG
- k. Administration of intravenous and intraventricular thrombolysis
- l. Interpretation of CT and MR standard neuroimaging and perfusion studies and biplane contrast neuraxial angiography
- m. Perioperative and postoperative clinical evaluation of neurosurgical and interventional neuroradiology patients
- n. Application of systemic moderate hypothermia

**4. *Advanced Neurocritical Care (may be considered optional for neurointensivists)***

- a. Performance and interpretation of cerebral multimodality monitoring (pH, pCO<sub>2</sub>, laser Doppler, microdialysis, NIRS, P<sub>bt</sub>O<sub>2</sub>, etc.)
- b. Intrathecal administration of chemotherapy, and radiographic agents
- c. Endovascular neurosurgical training (e.g., GDC coil placement, arterial stenting, cerebral angioplasty, intra-arterial thrombolysis)
- d. 2-D Duplex ultrasonography
- e. Interpretation of SPECT and PET
- f. Insertion of ventricular drainage and parenchymal ICP monitoring devices and cerebral oximetric or perfusion monitor placement
- o. Lumbar drain insertion

## **C. GOALS**

The overall goals of the educational program are:

- A. To provide supervised training in patient care in the neurological intensive care setting. This includes the diagnosis and management of life-threatening neurological diseases, as well as the medical conditions that frequently occur as complications.
- B. To provide supervised training in technical aspects and procedures related to the practice of neurological intensive care.
- C. To provide training and mentoring in fundamental aspects of clinical and/or basic science research related to neurological intensive care.
- D. To provide training in administrative, management, and economic aspects of neurological intensive care, with a focus on collaborative practice and multi-disciplinary care delivery.
- E. To allow the trainee to develop a sense of purpose with regard to ethical and humanistic aspects of care, with an emphasis on compassion and respect for patient-centered values.

- F. To foster the trainee's transition into a career as an independent, responsible, highly competent and self-sufficient neurointensivist.

## **D. OBJECTIVES**

Advanced training programs in neurological intensive care will have the following general purposes and goals (adapted from the ABMS/ACGME General Competencies):

### **A. Patient Care:**

Neurointensive care trainees are expected to provide patient care that is compassionate, appropriate and effective for the promotion of health, prevention of illness, treatment of disease, and at the end of life.

- 1) Gather accurate, essential information from all sources, including medical interviews, physical examinations, medical records and diagnostic/therapeutic procedures.
- 2) Make informed recommendations about preventive, diagnostic and therapeutic options and interventions that are based upon clinical judgment, scientific evidence, and patient preference.
- 3) Develop, negotiate and implement effective patient management plans and integration of patient care.
- 4) Perform competently the diagnostic and therapeutic procedures considered essential to the practice of neurological intensive care.

### **B. Medical Knowledge:**

Neurointensive care fellows are expected to demonstrate knowledge of established and evolving biomedical and clinical sciences, and the application of their knowledge to patient care and the education of others.

- 1) Apply an open-minded, analytical approach to acquiring new knowledge.
- 2) Access and critically evaluate current medical information and scientific evidence.
- 3) Develop a clinically applicable knowledge of the basic and clinical sciences that underlie the practice of neurointensive care.
- 4) Apply this knowledge to clinical problem-solving, clinical decision-making, and critical thinking.

### **C. Practice-Based Learning and Improvement:**

Neurointensive care fellows are expected to be able to use scientific evidence and methods to investigate, evaluate and improve patient care practices.

- 1) Identify areas for improvement and implement strategies to enhance knowledge, skills, attitudes and processes of care.
- 2) Analyze and evaluate practice experiences and implement strategies to continually improve the quality of patient practice.
- 3) Develop and maintain a willingness to learn from errors and use errors to improve the system or processes of care.
- 4) Use information technology or other available methodologies to access and manage information, support patient care decisions, and enhance both patient and physician education.

**D. Interpersonal and Communication Skills:**

Neurointensive care fellows are expected to demonstrate interpersonal and communication skills that enable them to establish and maintain professional relationships with patients, families, and other members of the health care team.

- 1) Provide effective and professional consultation to other physicians and health care professionals and sustain therapeutic and ethically sound professional relationships with patients, their families and colleagues.
- 2) Use effective listening, nonverbal, questioning, and narrative skills to communicate with patients and families.
- 3) Interact with consultants in a respectful, appropriate manner.
- 4) Maintain comprehensive, timely, and legible medical records.

**E. Professionalism:**

Neurointensive care fellows are expected to demonstrate behaviors that reflect a commitment to continuous professional development, ethical practice methods, an understanding and sensitivity to diversity and a responsible attitude toward their patients, their professional, and society.

- 1) Demonstrate respect, compassion, integrity and altruism in relationships with patients, families, and colleagues.
- 2) Demonstrate sensitivity and responsiveness to gender, age, culture, religion, sexual preference, socioeconomic status, beliefs, behaviors and disabilities of patients and professional colleagues.
- 3) Adhere to principles of confidentiality, scientific/academic integrity, and informed consent.
- 4) Recognize and identify deficiencies in peer performance.

**F. Systems-Based Practice:**

Neurointensive care fellows are expected to demonstrate both an understanding of the contexts and systems in which neurointensive care is provided, and the ability to apply this knowledge to improve and optimize patient care.

- 1) Understand, access and utilize the resources, providers and systems necessary to provide optimal care.
- 2) Understand the limitations and opportunities inherent in various practice types and delivery systems, and develop strategies to optimize care for the individual patient.
- 3) Apply evidence-based, cost-conscious strategies to prevention, diagnosis and disease management.
- 4) Collaborate with other members of the health care team to assist patients in dealing effectively with complex systems and to improve systematic processes of care.

#### **E. METHODS OF TRAINING TO BE USED**

- A. The educational experience will be provided in the form of a post-residency fellowship, to be conducted at a participating member institution, qualified and in compliance with the program requirements. It is anticipated that in most instances the duration of the fellowship will be two years.
- B. The educational experience will be outlined in the form of a curriculum meeting the standards and requirements specified in the training program curriculum content (**Appendix A**) and training program requirements (**Appendix B**).
- C. Ongoing feedback in the form of progress reports and evaluations will be performed by the program director and designated faculty and provided to the trainee, and assessments of program success and faculty performance will be provided by trainees to the faculty.

#### **F. METHODS OF EVALUATION**

The overall success of the program must be documented in written record and may include:

- A. Yearly tabulation of total applicants and number of accepted applicants.
- B. Total trainees completing the programs.
- C. Record of trainee presentations, abstracts, peer reviewed and other publications during the trainee program.
- D. Documentation of the first professional employment position or activity of the trainee immediately following completion of the training program.
- E. Productivity can also be supplemented by summarizing subsequent employment positions, honors, or other pertinent indicators of recognition received by trainees at any time following the training program experience.

- F. The number of patients who take a certification examination in neurological intensive care, and their performance on the exam.

**G. METHODS OF FEEDBACK**

- A. Evaluation of program strengths and weaknesses, based on evaluations and perceptions of the trainees, faculty, directors should be performed by the Program Director at least yearly and on an add-needed basis.
- B. A summary of these issues should be made yearly by the program director. The directors should discuss potential improvements with the faculty and minutes should be recorded regarding the recommendations.
- C. Reasonable efforts to incorporate helpful or constructive improvements should be made when logistically possible by the directors in the subsequent years of the training program.