

Neuroanesthesia Rotation - Core

The goal of your neuroanesthesia rotation is to provide you with more detailed knowledge and clinical skills in neuroanesthesia as a prerequisite not only for passing the anesthesia board exam but also as a preparation for future practice.

During your rotation with us, you will be expected to do a thorough preoperative evaluation, formulate an anesthetic plan, and act as a primary anesthetic caregiver under the appropriate faculty supervision. We realize that the schedule can sometimes run into the late afternoon. You are encouraged to finish those cases, which are more interesting and challenging, such as cerebral aneurysm surgery, head trauma, or resection of an arteriovenous malformation.

At the conclusion of the neuroanesthesia rotations you will be familiar with a variety of basic and clinical topics. This is accomplished by your OR experience, completing your reading assignments and by your participation in informal discussions with faculty in the operating room. I suggest you keep a record of the topics you have discussed and the cases you have been involved in.

Please contact Dr. Rusa or Dr. Shangraw during the first day of your neuroanesthesia rotation for an orientation. You should obtain educational material from the Education Coordinator.

Goals

Medical Knowledge

Residents are expected to understand:

- Understand the basic anatomy of the nervous system, including blood supply to the brain and spinal cord, the organization of the motor and sensory tracts within the spinal cord, and the ventricular system and normal flow of CSF.
- Understand the general concepts of cerebrospinal fluid physiology.
- Understand the concepts involved in cerebral blood flow (CBF) and factors that affect it, including normal cerebral blood flow autoregulation, cerebral perfusion pressure, cerebral blood flow response to CO₂, and the relationship between CBF and cerebral metabolism. The effects of the following classes of drug on the CBF, CO₂ reactivity, coupling of flow and metabolism should be understood: hypnotic agents (barbiturates, benzodiazepines, etomidate, and propofol), ketamine, nitrous oxide, potent inhalational agents, opiates and antagonists and muscle relaxants.
- Understand the general use of fluids including crystalloid, colloid, dextrose-containing solutions and osmotic and non-osmotic diuretics in patients with intracranial pathology.
- Understand the general principles, advantages and disadvantages of the prone, lateral, 3/4 prone, and supine head turned away positions. Understand the hemodynamic and respiratory consequences of the prone and lateral positions.
- Understand the management of increased intracranial pressure for craniotomy and the use of hyperventilation, barbiturate infusions, osmotic and loop diuretics and CSF drainage.
- Understand the pathophysiology of the cerebral circulation in patients with ischemic cerebrovascular disease and the inherent cardiovascular pathology associated with these patients. Learn to evaluate the vertebral and carotid circulation in these patients.
- Understand the effects of subarachnoid hemorrhage on cerebral physiology and other organ systems.
- Understand the natural history of aneurysms, the rationale behind the timing of aneurysm surgery, the Hunt and Hess and WFN classifications of neurologic grading, the physiology of transmural pressure in aneurysms and factors that predispose to aneurysm rupture or cerebral ischemia.
- Understand the rationale for using intraoperative EEG /SSEP monitoring and burst suppression technique in cerebral aneurysm surgery.
- Understand the basic differences between infratentorial, supratentorial and pituitary tumors, and the implication of their size and speed of growth in management.
- Understand the consequences of the sitting position with respect to the changes in the hemodynamic, neurologic and respiratory functions that can occur.
- Understand the Venous air embolism – its prevention, diagnosis and treatment in both the sitting and prone positions.

- Understand the pathophysiology of neuroendocrine tumors and the systemic implications of the disorders.
- Understand the degree of complexity in types of spine surgery: foraminotomy, anterior, and posterior cervical laminectomy, foraminotomy and fusion, laminectomy for spinal cord tumors or lumbar/thoracic fusions, corpectomy.
- Understand the basics of neuro-physiologic monitoring in spine surgery, the appropriate effects of anesthetics and the potential use of intraoperative “wake-up” test for motor evaluation.
- Understand the indications and uses of evoked potential monitoring.
- Understand the general measurements of evoked potentials (latency and amplitude), and the effects of temperature, hypoperfusion, ischemia and anesthetic agents on the evoked potentials.
- Understand the pathophysiology of acute and chronic spinal cord injury at any level, its disruption of normal CNS, hemodynamic and respiratory physiology (with particular attention to autonomic dysreflexia), and what impact this disruption has on anesthetic management. The consequences of using depolarizing muscle relaxants in these patients should be understood.

Patient Care

Residents are expected to:

- Understand the type and severity of major neurosurgical problem(s), as well as other medical problems that may affect the pathology, by reviewing and critically assessing the medical history, pertinent laboratory data and physical examination of patients.
- Understand the rationale for the choice of agents in an elective craniotomy. Understand the implications of elevated ICP and its use for guiding hemodynamic therapy.
- Demonstrate skill in the selection and execution of such an anesthetic plan, which allows, with a minimum of hemodynamic change, rapid reversal of anesthesia after craniotomy to assess neurologic function quickly postoperatively.
- Manage craniotomy for a cerebral aneurysm, with appropriate direction.
- Understand the anesthetic implications of the sitting position and manage such a case, with direction.
- Have a working knowledge of indications and placement of a precordial Doppler, and recognition of air entrainment.
- Understand the urgency of emergent craniotomy for traumatic brain injury.
- Understand the patient population, which would not be suitable for extubation considering CNS, neuromuscular and other organ system pathology.
- Manage craniotomy for neuro-endocrine disorders.
- Understand the anesthetic implications of intraoperative MRI
- Understand the differences between myelopathic and radiculopathic pain and plan for appropriate airway management and monitoring.
- Understand the patient population, which may require special techniques such as awake intubation and positioning.
- Demonstrate in-line stabilization in patients with spinal cord injury
- Manage anesthetic for spine surgery including those cases with potential for massive transfusion.
- Demonstrate the planning for and execution of a complex case (i.e. fiberoptic intubation, arterial line, central line).
- Demonstrate various methods of placing a central venous catheter.
- Understand airway management and sedation requirements, blood pressure control, and potential complications in patients undergoing stereotactic neurosurgery.
- Understand basic principles of CT and MRI imaging techniques.

Interpersonal and Communication Skills

Residents are expected to:

- Demonstrate therapeutic and ethically sound relationships with patients.
- Facilitate patient care through clear concise communication.
- Demonstrate understanding of his/her role as a member of the anesthesia team.
- Understand the necessary verbal, non-verbal and written communication skills with the attending, residents, and OR staff.

Professionalism

Residents must demonstrate a commitment to carrying out professional responsibilities, adherence to ethical principles, and sensitivity to a diverse patient population.

Residents are expected to:

- Demonstrate respect, compassion, and integrity; a responsiveness to the needs of patients and society that supersedes self-interest; accountability to patients, society, and the profession; and a commitment to excellence and on-going professional development.
- Demonstrate a commitment to ethical principles pertaining to provision or withholding of clinical care, confidentiality of patient information, informed consent, and business practices.
- Demonstrate sensitivity and responsiveness to patients' culture, age, gender, and disabilities.

Practice Based Learning and Improvement

Residents are expected to:

- Understand the role of information technology in anesthesiology practice.
- Utilize information technology to inform professional practice.
- Understand Evidence Based Medicine theory and practice.
- Demonstrate reflective clinical performance.
- Exhibit metacognitive and life long learning skills.
- Understand the anesthesiologist's role in education of other health care professionals and support staff.

System Based Practice

Residents are expected to:

- Demonstrate awareness of and responsiveness to the larger context and system of health care including the institutional level.
- Understand the various forms of information technology in day-to-day practice.
- Understand the needs of different medical teams and other health care professionals in patient care.

Objectives

Medical Knowledge

Residents are expected to:

- Describe the basic anatomy of the nervous system, including blood supply to the brain and spinal cord, the organization of the motor and sensory tracts within the spinal cord, and the ventricular system and normal flow of CSF.
- Explain cerebrospinal fluid physiology, including formation, reabsorption, and flow of CSF.
- Explain the concept of cerebral blood flow (CBF) and factors that affect it, including normal cerebral blood flow autoregulation, cerebral perfusion pressure, cerebral blood flow response to CO₂, and the relationship between CBF and cerebral metabolism. Describe the effects of the following classes of drugs on the CBF, CO₂ reactivity, coupling of flow and metabolism: hypnotic agents (barbiturates, benzodiazepines, etomidate, and propofol), ketamine, nitrous oxide, potent inhalational agents, opiates and antagonists and muscle relaxants.
- Present a rationale for the choice of intravenous fluids including crystalloid, colloid, dextrose-containing solutions and osmotic and non-osmotic diuretics in patients with intracranial pathology.
- Describe the indications, advantages and disadvantages of the prone, lateral, 3/4 prone, and supine head turned away positions. Explain the hemodynamic and respiratory consequences of the prone and lateral positions.
- Explain the management of increased intracranial pressure for craniotomy and the use of hyperventilation, barbiturate infusions, osmotic and loop diuretics and CSF drainage.
- Explain the pathophysiology of the cerebral circulation in patients with ischemic cerebrovascular disease and the inherent cardiovascular pathology associated with these patients. Learn to evaluate the vertebral and carotid circulation in these patients.
- Describe basic acute changes caused by a subarachnoid hemorrhage on the cerebral physiology and its potential effects on other organ systems.
- Provide the rationale behind the timing of aneurysm surgery.

- Describe the Hunt & Hess and WFN classifications of neurologic grading, the physiology of transmural pressure in aneurysms and factors that predispose to aneurysm rupture or cerebral ischemia.
- Provide the rationale behind the use of EEG and SSEP monitoring and the burst suppression technique in cerebral aneurysm surgery.
- Describe the advantages and disadvantages of the sitting position with respect to the hemodynamic, neurologic and respiratory consequences that can occur.
- Explain venous air embolism.
- Describe venous air embolism prevention, diagnosis and treatment in both the sitting and prone positions.
- Compare and contrast infratentorial, supratentorial and pituitary tumors and explain the implications of the tumors' size and speed of growth in management.
- Explain the pathophysiology of neuroendocrine tumors and the systemic implications of the disorders.
- Describe the following types of spine surgery and their degree of complexity: foraminotomy, anterior, and posterior cervical laminectomy, foraminotomy and fusion, laminectomy for spinal cord tumors or lumbar/thoracic fusions, corpectomy.
- Describe the basics of neuro-physiologic monitoring in spine surgery and the effects of anesthetics on such monitoring
- Explain the potential use of intraoperative "wake-up" test for motor evaluation.
- Detail the indications and uses of evoked potential monitoring – visual, brainstem, somatosensory and motor potentials.
- Describe the basic measurements of brainstem, somatosensory, and motor evoked potentials, what they look like and what they monitor (i.e. what their neural generators are).
- Describe the pathophysiology of acute and chronic spinal cord injury at any level, its disruption of normal CNS, hemodynamic and respiratory physiology (with particular attention to autonomic dysreflexia), and what impact this disruption has on anesthetic management. Explain the consequences of using depolarizing muscle relaxants in these patients.
- Explain the basic principles of anesthetic management of acute spinal cord injury, including the rationale for intravenous steroids.

Patient Care

Residents are expected to:

- Define the type and severity of major neurosurgical problem(s), as well as other medical problems that may affect the pathology, by reviewing and critically assessing the medical history, pertinent laboratory data and physical examination of patients.
- Manage an elective craniotomy, understanding the rationale for the choice of agents and intravenous fluids. Select appropriate pharmacologic agents for blood pressure control, knowing their potential effect on intracranial pressure.
- Explain the implications of elevated ICP and demonstrate the working knowledge of appropriate treatment for elevated ICP and hemodynamic management.
- Plan and execute an anesthetic to afford rapid reversal of anesthesia with a minimum of hemodynamic change after craniotomy to assess neurologic function quickly postoperatively.
- Manage a craniotomy for a cerebral aneurysm with assistance; explain the rationale behind the choice of monitoring and anesthetic techniques, burst suppression in particular.
- Manage a case in the sitting position with direction.
- List the indications for a precordial Doppler and place it correctly; recognize air entrainment.
- Place a central venous catheter using the internal jugular and subclavian approaches. Perform and/or describe the technique of right-sided atrial catheter placement for diagnosis and management of air embolism.
- Manage emergent craniotomy for traumatic brain injury with assistance, understand the need for rapid OR set-up, induction and choice of monitoring and anesthetic techniques.
- Recognize which patients would not be suitable for extubation considering CNS, neuromuscular and other organ system pathology.
- Manage craniotomy for neuro-endocrine disorders.
- Describe safety precautions and special equipment and monitoring needs associated with intraoperative use of MRI.
- Identify the differences between myelopathic and radiculopathic pain and plan for appropriate airway management and monitoring.

- Recognize which patients with spinal cord pathology may require special techniques such as an awake intubation and positioning.
- Perform explain in-line stabilization in patients with spinal cord injury, with assistance.
- Create and defend an anesthetic management plan for spine surgery including those cases with potential for massive transfusion.
- Set up, organize and execute the planning of a complex case (i.e. fiberoptic intubation, arterial line, central line).
- Describe airway management and sedation requirements, as well as potential complications in patients undergoing stereotactic neurosurgery. Know the target and the optimal pharmacologic agents regarding blood pressure control in patients undergoing stereotactic functional neurosurgery under monitored anesthesia care.
- Describe major differences in CT and MRI imaging techniques and identify gross abnormalities, e.g. intracerebral hemorrhages and large masses or strokes.

Interpersonal and Communication Skills

Residents are expected to:

- Elicit patient medical history and obtains other pertinent information in an effective and efficient manner.
- Discuss anesthetic plan, risks and alternatives in an appropriate detail while showing sensitivity to patient's needs and concerns.
- Exhibit polite language and behaviors.
- Employ the necessary verbal, non-verbal and written communication skills with the attending, residents, and OR staff.
- Deliver concise, organized case presentations to the staff that include pre-anesthetic concerns and management.

Professionalism

Residents are expected to:

- Demonstrate responsibility and physical and mental attentiveness in a positive and constructive manner.
- Cope with diversions and minimize distractions while maintaining vigilance.
- Initiate interactions with patients, colleagues and peers using respectful communication and conscientious behaviors.
- Arrive for clinical and learning responsibilities in a timely and punctual fashion; be prepared to perform tasks, explain reasoning and reasoning process.
- Employ electronic/technology and communication devices in a timely fashion to support patient care and teamwork.
- Answer pages in a timely manner.
- Demonstrate willingness to show consideration and appreciation for patients and co-workers.
- Interact with colleagues and peers in a respectful and conscientious manner.
- Identify respectful interactions.
- Value patients' leadership role in their own care.
- Respond to questions, requests for information, follow-up, and other communication in a timely manner.
- Exhibit compassion, empathy and support in patient care and professional interactions.
- Appreciate patient vulnerability.
- Communicate in an open, inclusive manner ensuring appropriate patient care and teamwork.
- Acknowledge diversity while providing equanimity in patient care and therapeutic and work relationships.
- Initiate interactions and manage exchanges with patients, colleagues and peers using respectful communication and conscientious behaviors.
- Demonstrate truthful and ethical standards in professional interactions and conduct.
- Adhere to departmental and university policies and procedures.
- Exhibit honesty in recordkeeping and medical records.
- Present information, concerns, and suggestions without bias or for personal gain.

- Report concerns, errors, or potential problems to attending.
- Inform patients and appropriate caregivers about care and care options using HIPAA and PARQ.
- Demonstrate an understanding of the value of continuing education and life-long learning through membership to professional organizations including OMA & ASA.

Practice Based Learning and Improvement

Residents are expected to:

- Utilize information technology in anesthesiology practice.
- Use information technology to manage information, access on-line medical information and support self-education.
- Locate and analyze evidence from scientific studies related to their patients' health problems.
- Analyze cases performed personally and perform practice-based improvement.

System Based Practice

Residents are expected to:

- Recognize how their patient care affects other health care professionals and the health care organization, and how these elements of the system affect their own practice.
- Act as advocates for quality patient care.
- Realize how their practice choices affect health care costs.

Instructional Methods

Residents will be assigned to the Neuro OR by the daily scheduler, giving preference to the resident(s) assigned to the neuroanesthesia rotation.

Residents will discuss their preoperative assessments, monitoring plan, anesthetic and postoperative plan with their attending anesthesiologist the day prior to the scheduled case.

Case based or clinical case discussions and formal reading/didactic material will be used during the rotation.

Suggested discussion points:

- CBF and autoregulation, ICP, CPP
- Drugs and CBF and ICP
- Drugs and EEG and SSEP
- Fluid management
- Treatment of elevated ICP
- Monitors of ICP
- Supratentorial tumor
- SAH, cerebral aneurysm
- AVM
- EC-IC bypass
- Head trauma
- Posterior fossa surgery
- Sitting craniotomy
- Epilepsy surgery
- Awake craniotomy
- Spine surgery: acute and chronic sp. cord injury
- Functional neurosurgery

Assessment and Evaluation

Your performance will be evaluated in concert with the current resident clinical evaluation process of daily evaluations and verbal feedback as well as the global narrative rotation evaluation. We would also welcome your feedback and suggestions so that we can make the necessary modifications and/or improvements for future residents. We are looking forward to working with you.

References and Resources

1. Chapters on Cerebral Physiology and Neurosurgical Anesthesia by John C. Drummond and Piyush M. Patel (from Anesthesia edited by Ronald D. Miller).
2. Anesthesia and Neurosurgery by J. Cottrell and D. Smith, Fourth Edition
The following chapters are highly recommended:

CH 7: Effects of Anesthetic Agents on CBF, Metabolism, and ICP, pp. 129 – 143
CH 9: Evoked Potentials, pp. 183 – 200
CH 10: EEG, pp. 201 – 217
CH 14: Supratentorial Mass, pp. 297 – 317
CH 18: Cerebral aneurysms, pp. 367 – 396
CH 20: Interventional Neuroradiology; Pts with Arteriovenous malformations, pp. 399-423
CHs 31 and 32: Severe Head Injury, pp. 663 – 713
3. A folder containing several articles on a variety of neuroanesthesia related topics
4. Guidelines for neurosurgical anesthesia at OHSU and neuroanesthesia related journal articles available on J:drive

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