PDAF Neuroanesthesia and Neurocritical Care- Curriculum

GUIDELINES FOR COMPETENCY BASED POSTGRADUATE TRAINING PROGRAMME FOR PDAF IN NEUROANESTHESIA AND NEUROCRITICAL CARE

Program outcome:

With the significant advances in the field of neurosciences observed in the past few decades, the relatively new field of neuroanesthesia and neurocritical care has also made parallel rapid progress. With better understanding of brain physiology, and availability of high precision gadgets and instruments, neuroanesthesia has rightly earned its place as an independent speciality. The fragility of the brain and spinal cord and the multitude of complexities involved in neurosurgery and interventional neuroradiological procedures demand dedicated training in neuroanaesthesia. It has been observed that institutions with dedicated neuroanesthesia and neurocritical care services have provided better care and optimal outcomes for patients with neurological diseases. With thousands of complex neurosurgical cases being carried out throughout the day across the country, the need for dedicated professionals with specialized and focused training in the science of neuroanesthesiology is being increasingly felt to improve the quality and outcome of patient care. The molding of such dedicated professionals can be achieved through establishment of a structured training program which includes in-depth exposure into the theoretical, clinical and practical realms of neuroanesthesiology in-sync with the latest technological advancement and encouragement for independent scientific research.

Keeping in mind the above, a two-year Post-Doctoral Advanced Fellowship (PDAF), Neuroanesthesia and Neurocritical care course is proposed to be formulated to train the anesthesia postgraduates in the nuances of neuroanaesthesiology and equip them with the necessary skills to help them function as consultants in Neuroanesthesiology and Neurocritical care. The thorough, exhaustive and comprehensive training in Neuroanesthesia and Neurocritical care which will be imparted to the prospective candidates is expected to achieve the following objectives at the end of the course:

1. Acquire sufficient theoretical knowledge in Neuroanesthesia and Neurocritical care along with the allied specialties of neurosurgery, neurology and interventional radiology.
2. Assume the role of a consultant neuroanesthesiologist well-equipped to deal with pre-anesthetic evaluation and optimisation as well as the intraoperative management of all sorts of routine and emergency neurosurgical cases and develop a reasonable amount of proficiency in performing mandatory procedures independently. His role as a consultant in neurocritical care focuses on the diagnosis and treatment of life-threatening diseases of the neurological disorder including brain, spinal cord and peripheral nervous system, traumatic brain injury, spinal cord injury, cerebral edema, cerebrovascular accident (Ischemic stroke, hemorrhagic stroke, subarachnoid

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Colour Coding
Global GREEN
Regional BLUE
National ORANGE
Local (State) PINK

hemorrhage etc.) ruptured aneurysms, encephalitis and meningitis, refractory seizures, and complicated brain and spine diseases.

3. Develop proficiency in advanced patient monitoring techniques like intracranial pressure, cardiac output, electroencephalography, evoked potentials, transcranial doppler, cerebral oximetry, jugular venous oximetry, microdialysis and echocardiography.
4. Be proficient in the postoperative management including ventilatory management and medical management of neurological and systemic complications.
5. Management of critically ill patients including various modes of mechanical ventilation, sepsis and multiorgan dysfunction. Management of illnesses specific to neurological diseases like status epilepticus, encephalitis, meningitis, Guillain Barre Syndrome, myasthenia gravis, multiple sclerosis etc.
6. Be able to communicate effectively with the patients, their family, colleagues, inter-departmental personnel, technicians, nursing staff, teachers and students.
7. Develop a scientific bent of mind and the essential skills of conducting medical research, and present them in scientific forums and publish in relevant peer-reviewed journals.

Such an extensive training shall cater to the health care needs of patients of different neurological and neurosurgical diseases at the **local, regional and national levels and help deliver quality care of international standards to our population.**

Eligibility Requirements

Students who have completed MD/DNB from recognised institutions of the country in Anesthesiology are eligible for PDAF in Neuroanesthesiology and Neurocritical Care

SUBJECT SPECIFIC LEARNING OBJECTIVES

At the end of the course the candidate who is eligible for a DM degree in Endocrinology should A **During the PDAF program of Neuroanesthesiology and Neurocritical Care, a student will acquire:**

a. Clinical, analytical, self-directed motivational learning with perioperative skills required in the anesthetic management of neurosurgical patients which include congenital, parenchymal, vascular, inflammatory, traumatic and oncological ailments of brain and spinal cord prevalent **in the region, state and country.**

b. Have a basic understanding of the disease burden, epidemiology, patho-physiology and key determinants of neurosurgical disease and neurotrauma **in the region, state and country.**

c. Sound clinical and procedural skills required in the appropriate management of postoperative neurosurgical patients in the postanaesthesia care unit/intensive care unit. Additionally, the state of art and evidence-based management of neurological diseases and neurotrauma patients who require intensive care therapy.

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d. Develop effective communication skills and build rapport with the patient/ attendants.

e. Develop inquisitiveness and ability to provide rational explanation which helps in formulating research questions, planning, initiating and conducting clinical and applied research at **institutional, state, national and international levels.**

f. Demonstrate compassion for patients and their families and have an ethical and holistic approach to help them deliver evidence-based, respectful ethical care to the patients.

g. Develop mentorship, leadership and networking skills to help teach, train and impart clinical and research skills to future neuroanesthesiologist**in the state andcountry.**

The student is expected to gain knowledge in the following FOUR key areas:

A. **Theoretical Knowledge:**

a. Anatomy :

Anatomy of the brain including cranial nerves, spinal cord, and peripheral nerves. Vascular anatomy of CNS, spinal and extracranial vessels. Gross anatomy of head, neck, vertebral column, airways, lungs, heart and embryology of nervous system.

b. Physiology:

Normal physiology of CNS, spinal cord, respiratory system, cardiovascular system, hepatic system, renal system and their deviations during pathological states in adults. Physiological variations in special groups like **paediatric, elderly, pregnant patients, transgenders etc**.

c. Pharmacology:

Extensive understanding of pharmacokinetics and pharmacodynamics of anaesthetic and other medical drugs especially in context to their effect on brain and spinal cord. Alongside, their metabolism, interactions and adverse effects.

d. Pathology:

Understanding of the pathological basis of neurosurgical as well as neurological disorders along with those affecting respiratory, cardiovascular, renal and hepatic systems and the effect of these pathological processes on the anaesthetic management of the concerned patients.

e. Microbiology:

Understanding of epidemiology, etiology, pathogenesis, investigational and therapeutic management of infectious disease affecting neurologically ill patients and institutional antimicrobial policy

f. Anaesthetic equipments:

Design, parts, indications, techniques and safety issues related to equipment used in neuroanesthesia practice.

g. Pain:

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Colour Coding

Global	GREEN
Regional	BLUE
National	ORANGE
Local (State)	PINK

Understanding of etiology, pathophysiology, diagnosis and management of acute postoperative and acute traumatic pain. Also, issues related with chronic pain syndromes and neuropathic pain diseases affecting the central nervous system and spinal cord.

h. Neuroimaging:

Basic understanding of commonly used imaging modalities used to diagnose neurosurgical afflictions which include X-rays, ultrasonography, DSA, CT, MRI, Angiography

B. Procedural skill:

a. Management of straight-forward and complex airway using conventional and advanced gadgets like supraglottic airway devices, videolaryngoscope, fiberoptic bronchoscope.

b. Invasive hemodynamic monitoring which includes Intra-arterial blood pressure, CVP and PA catheter.

c. Use of advanced neuromonitoring modalities like ICP monitor, SSEP, MEP, EMG, SjvO2, NIRS, BIS.

d. Percutaneous tracheostomy and ICD placement.

e. **Use of USG** for detection of lung pathology, airway ultrasound, interfascial plane blocks, ONSD, IVC diameter, vascular access.

f. TCD and its use peri-operatively and in the neurocritical care unit.

g. Regional blocks pertinent to neuroanesthesiai.e. scalp block, stellate ganglion block, erector spinae plane block, thoracolumbar interfascial plane (TLIP) block.

C. Research methodology:

a. Basics of statistical methods, types of studies, data presentation, planning and conduct of a study, basic parametric and non parametric tests, different tests of significance and use of software for data analysis like PASS, SPSS etc.

b. Critical analysis of published literature, drafting research proposals, learning the process of drafting a manuscript (including case reports, original article etc.) and an overview of the online submission system.

c. Identifying avenues for future research with special relevance to **local, national and international needs.**

D. Interpersonal and team work skills

a. Multidisciplinary clinical meetings with peers from other allied specialities like neurosurgery, neurology, neuroradiology and critical care.

b. Development of presentation skills (podium, paper, seminars, journal clubs) to generate scientific deliberation and interactions which shall help in knowledge and skill building and is likely to improve patient outcomes of the **region, state and country**.

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c. Development of a sense of teamwork during crisis situations encompassing all aspects of management of trauma patients in the causality, intraoperative catastrophes and also natural calamities/ disasters or pandemics which have a bearing on the local, national and international levels.

SUBJECT SPECIFIC COMPETENCIES

At the end of the course, the PDAF student will acquire the following competencies under the following three domains:

(A) Cognitive domain (Knowledge domain)

By the end of the course, the PDAF student should be able to demonstrate the following:

1. A detailed and comprehensiveunderstanding/knowledge about the general principles related to neuroanaesthesia, basic neuroanatomy and neurophysiology, respiratory physiology, cardiovascular physiology, renal physiology and acid base physiology.

2. Requisite physiological processes involved in the normal functioning of thebrain and their alterations in various diseases of the central nervous system. Have detailed understanding of the pharmacokinetics and pharmacodynamics of various anaesthetic drugs (intravenous and inhalational) used in neurosurgical as well as neurocritical care with its relevance to brain and spinal cord, their mechanism of actions, adverse effects, drug interactions with recent scientific evidence including knowledge of **antibiotic stewardship, anticonvulsants, anti-parkinson's drugs anticoagulants.**

3. In-depth theoretical knowledge about the pathological basis of neurologic diseases, neuroinfections, peripheral motor neuron disease, metabolic disorders, traumatic brain injury, brain death, cerebral vascular accidents, ischemic or haemorrhagic stroke, subarachnoid haemorrhage etc.

4. To have a basic understanding and clinically relevant understanding of neuro imaging using modalities like X-ray, Ultrasonography, Digital Substantial Angiography, Computed Tomography and Magnetic Resonance Imaging.

5. To have an understanding of neuromonitoring modalities both basic and advanced including cerebral/spinal blood flow, oxygenation and metabolism. Also have an understanding of basic and advanced hemodynamic monitoring modalities for better management of the patient in the operation theatre and/or neurointensive care unit.

6. Should be able to write and conduct a research proposal related to Neuroanaesthesiology in accordance with guidelines of the Ethics Committee and critically evaluate published literature in medical journals.

7. Have adequate knowledge of Statistics to enable critical evaluation and analysis of new literature.

8. Be well versed with different neuroanaesthesia and neurocritical care guidelines and their implications at **local, national** and **international level.**

(B) Affective domain (Attitudes including Communication and Professionalism)

1. Should be able to function as a part of a team, develop an attitude of cooperation with colleagues, interact with the patient, and the clinician or other colleagues of other specialities to provide the best possible diagnosis or opinion.
2. Always adopt ethical principles and maintain proper etiquette in dealing with patients, relatives and other health personnel and to respect the rights of the patient including the right to information and second opinion.
3. Develop communication skills to word reports and professional opinion as well as to interact with patients, relatives, peers and paramedical staff, and for effective teaching.
4. To develop astute communication skills so as to be able to break bad news and persuade/ convince the relatives of brain-dead patients for organ donation.
5. Todemonstrate empathy and equality when dealing with individuals of special groups like paediatrics, elderly, pregnant and transgenders.
6. Should have the ability to discuss, deliberate, review and examine scientific data, prepare and deliver lectures/presentations, take part in seminars, CME's, panel discussions and get the skills to present the information gained to students and colleagues.
7. To inculcate a spirit of healthy competitiveness while participating in scientific deliberations/ poster/ paper presentations/ participation in quiz etc. at **local, state, national and international forums.**
8. Politeness and courteousness towards subordinates, technical and nursing staff even at the times of crisis.
9. Punctuality, sincerity and strong sense of work ethics.

(C) Psychomotor domain

At the end of the course, the student should have acquired following skills:

1. Exposure to a whole range of cranial and spinal surgical procedures, **cranial and spine trauma,spinal instrumentation**, peripheral nerve repair, ventriculo-peritoneal shunt insertion, movement disorders, and exposure to awake craniotomy and functional neurosurgeries **including DBS and electrocorticography**. Whole range of minimally invasive neurosurgeries like keyhole craniotomy, ETV, endoscopic

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discectomy etc. The student will be exposed to anaesthetic management of neurosurgical patients in neuroradiological suite, management of patients in neurosurgical (postoperative and other critical patients) and neurological intensive care units.

2. In operation theatre,the student will practice and hone the necessary skills of conventional airway management and use of advanced airway gadgets including video-laryngoscope, supraglottic airway devices, fiberoptic bronchoscope. In addition to this; different strategies of ventilation along with fluid, electrolyte and temperature management. Appropriate use of intraoperative monitoring modalities like BIS, entropy, TCD and advanced hemodynamic monitoring. This will also include principles and applications of **advanced neuromonitors like SSEP, VEP, BERA, MEP, EMG.** Management of **neuroradiological procedures** with **special emphasis on anticoagulation and its reversal, contrast allergies and nephropathy, ischemic and haemorrhagic complications, management of hypothermia, deliberate hypotension and transient circulatory arrest. understanding of radiation safety and different zones of MRI.**
3. Intensive care management of postsurgical patients especially those planned for postoperative mechanical ventilation. Management of other critically ill neurological patients like status epilepticus, encephalitis, meningitis, multiple sclerosis etc. with special emphasis on sepsis, shock, coagulopathy, ARDS, vasopressor management. Essential skill set comprising central venous catheterisation, intra-arterial cannulation, percutaneous tracheostomy, ICD placement, lumbar drain placement and bronchoscopy and video EEG. **Use of ultrasonography in neurocritical care for assessment of fluid responsiveness, optic nerve sheath diameter, lung ultrasound, airway ultrasound and transthoracic echocardiography, colour doppler to rule out DVT.**
4. **Use of newer and novel postsurgical analgesic therapies like scalp block, erector spinae plane block, thoracic inter fascial plane block and patient-controlled analgesia.**
5. Basic understanding of common interventional pain procedures (head & neck, spine) like trigeminal neuralgia, styloid neuralgia and failed back syndrome.
6. To develop optimal degree of confidence while performing these procedures.

Syllabus

Course contents:

(i) Basic Neuroanatomy and Neurophysiology

1. Anatomy of the brain and spinal cord
2. Physiology of the brain and spinal cord
3. The cerebrospinal fluid circulation
4. Cerebral and spinal circulation, metabolism and effects of various anaesthetics (inhalational and intravenous agents)
5. Intracranial pressure and various herniation syndromes
6. Determinants of brain elastance, cerebral perfusion pressure, cerebral autoregulation, and metabolic coupling
7. Mechanism of neuronal injury and brain protection

(ii) Respiratory physiology

1. Physiology of spontaneous respiration and mechanical ventilation
2. Indications for mechanical ventilation
3. Modes of ventilation including invasive and non invasive ventilation
4. Weaning from ventilatory support
5. Complications of mechanical ventilation – recognition and management
6. Monitoring during ventilatory support

(iii) Cardiovascular physiology

1. Recognition and management of arrhythmias
2. Management of hemodynamic disturbances – hypotension, hypertension, myocardial ischemia, pulmonary oedema and heart failure
3. Knowledge of commonly employed vasoactive and anti-arrhythmic drugs

(iv) Renal physiology:

1. Fluid and electrolytes physiology and pathophysiology
2. Prevention, diagnosis and management protocol for acute kidney disease
3. Basic knowledge of renal replacement therapy

(v) Metabolic disorders

1. Pathophysiology and management of the Electrolyte disturbances in neurosurgical patients
2. Acid-base disorders
3 Understanding of endocrine disorders

(vi) Neurologic diseases

1. Neurologic examination
2. Manifestations of lobar syndromes
3. Neurological illnesses which can cause altered sensorium and critical care management
4. Differential diagnosis and work-up of patients presenting to Critical care.
5. Evaluation of patients in altered mental status with various coma Scores, and stroke scores
6. Nomenclature/criteria of altered levels of consciousness (coma, persistent & permanent vegetative states, minimally conscious states, etc)
7. Pathophysiology, and therapy of coma arising from metabolic, traumatic, infectious, mass lesions, vascular-anoxic or ischemic, drug-induced events

(vii) Specific Neurological diseases

1. Status epilepticus, refractory status epilepticus, super refractory status epilepticus, epilepsy and encephalopathies
2. Understanding the pharmacology and interactions of various anti-epileptic drugs
3. Guillian-Barrie syndrome
4. Muscle dystrophies with complication10
5. Systemic illnesses causing neurological manifestations: Neuropathy, myopathy, dyselectrolytemias, renal and hepatic failures, multi organ failure etc.

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6. Myasthenia gravis
7. Stroke (cerebrovascular accidents), and CVT (cortical venous thrombosis) with **special emphasis on hyperbaric oxygen therapy**
8. Other neurological diseases requiring ICU management

(viii) Neuroinfections

1. Bacterial, Viral, Fungal meningitis

2. Causative organisms of community-acquired & nosocomial meningitis/ventriculitis/abscesses along with preferred antibiotic agents

3. Describe the pharmacodynamic/ pharmacokinetic principles influencing CNS antibiotic activity

(ix) Peripheral Motor Neuron Disease

1. Review the natural history/expression of motor neuron disease related to degenerative diseases, infectious agents and inflammatory conditions
2. List the changes that occur in denervated muscles and implications for use of medications with activity at the neuro-muscular junction
3. Understand the presentation of respiratory failure and indications for non-invasive and invasive ventilatory support
4. Indications for and problems associated with plasmapheresis and intravenous immunoglobulin

5. Review the non-neurologic complications and management of motor neuron disease (cardiac denervation, intestinal movement disorders)

(x) Traumatic Brain Injury:

1. Pre-hospital care of the patient with neurologic injury

2. Resuscitation of the head injured

3. Airway management -conventional laryngoscopic intubation, insertion of LMA, fibreoptic intubation, manual inline stabilization (MILS), use of video-laryngoscope and surgical airway

(xi) Pharmacology

1. Basic idea on pharmacodynamics and pharmacokinetics of drugs, drug interactions, and complications of various drugs used in neurological patients

2. Sedatives and anaesthetic agents
3. Analgesics - Narcotics and non-narcotic agents
4. Muscle relaxants
5. Anticonvulsants
6. Vasopressors and inotropes
7. Antibiotics
8. Steroids
9. Anticoagulants and antiplatelets

(xii) Brain Death:

1. Criteria, determination and certification of Brain death

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2. Differential diagnosis e.g. drug induced, locked-in syndrome, etc
3. Organ donation: metabolic and hemodynamic management pending organ harvesting

(xiii) Cerebral Vascular Accidents:

1. Pathophysiology of stroke and management
2. Treatment modalities for arterial and venous stroke
3. Long-term care of stroke patients, rehabilitation
4. Understand the indications/contraindications/side effects of intraarterial/intravenous thrombolysis in ischemic cerebrovascular accident
5. Describe the natural history, risk factors and management options for "malignant infarcts".

6. Describe the natural history of intracerebral haemorrhage along with the role of early surgical interventional, and medical treatment (i.e. Blood pressure &glycemic control, administration of factor VIIa)

(xiv) Subarachnoid Haemorrhage

1. Various types of cerebral aneurysms
2. Describe the common aneurysm locations leading to SAH
3. Understand the clinical and radiographic grades of SAH
4. Methods used to detect cerebral vasospasm & strategies to treat Cerebral vasospasm to prevent secondary ischemic stroke
5. Indications for temporary external ventricular drains / permanent Shunts
6. Non-neurological complications of SAH and their management
7. Surgical clipping and coiling of cerebral aneurysm
8. Giant intracranial aneurysms and their implications
9. Anastomotic procedures in cerebral ischemia

(xv) Toxicity of anaesthetic agents on developing brain

(xvi) Monitoring in Critical Care

1. Neurological monitoring at the bedside
2. EEG- understanding basic EEG, role of continuous EEG monitoring in ICU
3. Monitoring cerebral oxygenation
4. Monitoring cerebral blood flow
5. Monitoring biomarkers
6. Hemodynamic monitoring
7. Respiratory monitoring
8. Intracranial pressure monitoring

(xvii) Nutrition in the neuro-critical care

1. General principles and indications
2. Total parenteral nutrition—indications, advantages/ disadvantages
3. Enteral nutrition: indications, advantages, and side effects
4. Nutrition in presence of metabolic and systemic diseases

(xviii) Neuroimaging

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1. Basics of neuroradiology
2. CT, MRI, TCD (Transcranial Doppler), USG (Ultrasound)
3. Interventional Neuroradiologic procedures
4. Identify the basic structures in the central nervous system (ventricles, cisterns, sinuses, major anatomic landmarks)
5. List the imaging techniques/signs used to identify acute intracranial haemorrhages, mass lesions, arterial and venous lesions, and ischemic penumbras/infarcts 13

6. Distinguish imaging characteristics of SAH, epidural hematomas, subdural hematomas, intraparenchymal haemorrhage and relate to anatomic structure

7. Understanding the concepts of medical and surgical management of various emergencies based on imaging and various decision paradigms

8. Management of complications in neuroradiological procedures

xix) General principles:

1. General principles of Critical Care
2. Organization of Critical Care
3. An awareness of the importance of communication skills and interpersonal relationships
4. Various Scoring Systems
5. Admission and Discharge criteria in Neuro-intensive Care Unit
6. Transport of the patients – pre-hospital and intra-hospital
7. Medical Ethics
9. Principles of consent taking and details of informed consent
10. Sterilization procedures
11. Maintenance of asepsis
12. Organizational capabilities, leadership qualities required to administer, manage and delegate responsibilities in Critical care
13. Training on the development of protocols for Critical care management
14. Behavior and team work in neurocritical care
15. Anaesthetic management of various CNS tumors

(xx) Neuro-rehabilitation

Head injured and spinal cord injured patients

1. Prevention of acute problems
2. Attendant training and counselling
3. Understanding long-term goals in neuro-rehabilitation

(xxi) Chronic neurological diseases

1. Stroke
2. Brain tumours postoperative
3 Epilepsy

(xxii) Temperature regulation

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Needs: Local : Pink, National : Orange, Regional: light blue, International : green

1. Understand the physiology of temperature regulation in OT and ICU and management of hypothermia/ hyperthermia in the neuro-intensive care population

Newer additions:

1. **Neurotrauma procedures including perioperative management of traumatic brain injuries like EDH, SDH, contusions or skull fractures.**
2. **Management of traumatic spinal injuries (spinal/axial) including pre-hospital management, intrahospital transport, spinal stabilization and surgical interventions including airway management of such cases.**
3. **Complex spine instrumentation procedures including scoliosis repair**
4. **Minimally invasive neurosurgeries including cranial and spinal procedures,**
5. **Functional neurosurgeries including DBS, electrocorticography**
6. **Advanced neuromonitoring including SSEP, VEP, BERA, MEP, EMG.**
7. **Complex neuro-ophthalmologic and neuro-otorhinological surgeries.**
8. **Artificial intelligence and robotics relevant to spine and brain surgery.**
9. **Hyperbaric oxygen therapy relevant to stroke**
10. **Simulation**
11. **Ultrasonography in anaesthesiology**
12. **Antibiotic stewardship, anticonvulsants, antiparkinson's drugs, anticoagulants**
13. **TEG in massive haemmorhage**
14. **Knowledge of neurotoxicity**

The Objective of the 2-year training program is to train the medical postgraduate as a best-skilled "Neuroanaesthesiologist" in different aspects of theoretical, clinical and practical spheres of Neuroanaesthesiology and enable them to offer them skills to provide appropriate neuroanaesthetic care with the highest professional standards. This training will help to accomplish the **local, regional and national healthcare needs** for quality care commensurate with international standards.

Local level	Intracranial tumour surgery, especially complex brain tumours like large meningioma, cerebellopontine angle tumours, base of skull tumours.(These cases are refereed to our institute nit only from entire state but also from adjacent states like Bihar, MP and coumtries like Nepal) Our state has a high incidence of **road traffic accidents** which usually involve young patients and have significant association with head injuries, spinal injuries and neurological impairment. This necessitates urgent specialized management right from their admission in the casualty, preoperative optimization, operative/ interventional procedures, and postoperative intensive care management till their discharge/home care. Our state has a significant burden of **spinal (congenital/ acquired/traumatic, degenerative diseases) like neural tube defects, atlantoaxial dislocation, kyphoscoliosis, traumatic spinal fractures, disc**

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	disorders etc. As with other north Indian states, our state also has a high incidence of vascular diseases like **cerebrovascular aneurysms (commonest anterior communicating artery aneurysms) and arteriovenous malformations**. These are amenable to both surgical as well as neuroradiological therapies. As with other specialties of surgery, the paradigm shift towards **minimally invasive neurosurgical procedures** (transsphenoidal pituitary surgeries, keyhole craniotomies, neuro endoscopic procedures) and neuroradiological procedures are being observed in neurosurgery too. Course curricula are hence designed to meet the above specific objectives.
National level	Major burden is of Complex intracranial tumour surgeries India has a high incidence of road traffic accidents which usually involve young patients and have significant association with head injuries, spinal injuries and neurological impairment. This necessitates urgent specialized management right from their admission in the casualty, preoperative optimization, operative/ interventional procedures and postoperative intensive care management till their discharge/home care. Our state has a significant burden of **spinal (congenital/ acquired/traumatic, degenerative diseases)** like neural tube defects, atlantoaxial dislocation, kyphoscoliosis, traumatic spinal fractures, disc disorders etc. As with other north Indian states, our state also has a high incidence of **vascular diseases** like cerebrovascular aneurysms (commonest anterior communicating artery aneurysms) and arteriovenous malformations. These are amenable to both surgical as well as neuroradiological therapies. As with other specialties of surgery, the paradigm shift towards minimally invasive neurosurgical procedures (transsphenoidal pituitary surgeries, keyhole craniotomies, neuro endoscopic procedures) and neuroradiological procedures is being observed in neurosurgery too. Along with other central nervous system malignancies like gliomas in adults and astrocytomas in pediatrics form a significant proportion of the national disease burden, often amenable to the surgical treatment they consist one of the most commonly performed surgeries which require precision-based anesthetic and perioperative care. Infective diseases (like meningitis and encephalitis) and non-infective diseases (like myasthenia gravis, Guillian Barre Syndrome, motor neuron diseases) require meticulous management in intensive care units and often require ventilatory assistance in addition to other supportive an therapeutic measures. Course curricula are hence designed to meet the above specific objectives.

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Global level	All the above mentioned health conditions are contemporary and have global relevance. India being a country with a high population density, has a significant disease burden in accordance with the global statistics. In tune with the international standards of advancement procedures like awake craniotomy, epilepsy surgeries and deep brain stimulation are being conducted which provide an added edge to the trainees.

TEACHING AND LEARNING METHODS

General principles

The basic aim of PDAF Neuroanaesthesiology and Neurocritical Care training and education is to produce dedicated professionals with requisite skills and thorough understanding of the nuances of anaesthetic management of neurosurgical patients. The specialized knowledge and skills are the result of focused and exhaustive training to develop reasonable levels of competency to successfully manage both elective and emergency neurosurgical cases during the entire perioperative period. This training consists of both clinical and academic aspects which include involvement in all stages of patient care and didactic lectures, seminars, audits, case presentations and journal clubs. Also included in the training process is the strong motivation to develop a research mindset and collaborative approach with specialties both in the clinical and academic contexts.

Teaching Methodology

During the period of teaching and training, the candidates will be following an in-service residency program. The postgraduate student shall be given the responsibility of managing and caring for patients in a gradual and phased manner under supervision, after the student demonstrates adequate skill and efficiency at each step. The responsibility consists of conducting anaesthesia for neurosurgical operations, managing patients in the neurointensive care unit, neurophysiology labs, various intensive monitoring procedures and ordering investigations. The day-to-day clinical work of the trainees will be under the guidance and supervision of consultants of the Department of Anaesthesiology. The schedule of the candidate postings is designed in a manner where the candidate gets rotated amongst various zones like operation theaters, postoperative neurosurgical and neurological intensive care units, neuroradiology suites, neurophysiology labs and pain clinics. Teaching sessions shall comprise of seminars, didactic lectures, case presentations, journal clubs, audits, and problem-based learning discussions and simulation sessions. Collaborative activities like interdepartmental meetings and clinical grand rounds to stimulate different clinical perspectives and inculcate a sense of team spirit. Encouragement for scientific presentations in the scientific forum at local, regional and national levels throughout the training duration to hone the interactive and presentation skills of the trainees.

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Formal teaching sessions

These include seminars, didactic lectures, case presentations, journal clubs, audits, problem-based learning discussions and simulation sessions along, practical operation theatre teachings and bedside teaching in the intensive care units. This will comprise of the following:

Minimum sessions

- Operation theatre teachings -Five days a week
- ICU bedside teaching (for those posted) -daily
- Seminar -twice a week
- Clinical audits -once a month
- Case presentation and discussion -twice a month
- Journal clubs -once a week
- PBLD -once a month
- Lectures -once a month
- **Simulation classes -once a month**
- Clinical grand rounds/ mortality meets -every Saturday

All above may refer to sessions conducted in the Department and not for each trainee.

Didactic Lectures

Didactic lectures are conducted by faculty members on contemporary topics.

Desirable activities

1. Each student is expected to attend accredited scientific meetings (CME, symposia, conferences, seminars).
2. Attend the 01/02 courses conducted by the institute especially those on research methodologies and biostatistics.
3. Present a poster/paper in regional/national conference.
4. Publication of research manuscript (correspondence, case reports, brief research, original article)

Log book

Each candidate will maintain a comprehensive log book carrying a record of various postings, their duration, procedures performed, presentations given and teaching sessions attended. The logbook will highlight the progress of the candidate and will be supervised by the consultants and signed periodically. It shall be signed by the Head of the Department

and a proficiency certificate from the Head of Department regarding the student's clinical competence, overall skillful performance of procedures and general approach toward patients will be necessary before the student is allowed to appear in the final examination. The Log Book shall also serve as a source to help in the internal evaluation of the trainee.

The **trainee shall be encouraged to undergo e-learning activities.**

- **Clinical postings:**

Recommended schedule for two years of training

Each trainee will undergo the following rotations for the described duration to familiarize and equip themselves with the intricacies of patient management related to that particular area. They will be actively involved in the entire peri-procedural/ clinical management of the patients in whichever zone they are rotated. Rotatory posting will be as follows:

Clinical neuroanaesthesia OTs	1 year 2 months
Neurology	1 month
Neurosurgical ICU	2 months
Postoperative ICU	2 months
Neuroradiology	1 month
Trauma centre (OT + ICU)	3 months
Pain	1 month

Research

All trainees will be encouraged to undertake independent projects and will actively be involved in ongoing research work of the department under the guidance and mentorship of faculty members. The trainee will also participate in various departmental research activities from time to time. It is desirable that the trainee has submitted at least one research manuscript for publication.

Evaluation methodology

At the end of the course the trainee will have to undergo both theory as well as practical examinations which will be conducted in the presence of internal as well as external examiners. Two internal examiners (one HOD, Department of Anaesthesiology, and another from the core faculty members) and two external examiners who will be reputed faculty members in the field of neuroanaesthesiology.

Theory exams

Will consist of three theory papers with the following titles as per the institute's norms.

1. Basic sciences as related to neuroanaesthesia

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2. Clinical aspect of neuro anaesthesia
3. Recent advances in neuro anaesthesia

Clinical Practical and Viva-voce

One long and two short cases will be allocated to the trainees and discussion thereon would last for approximately 30-40 minutes per case during and after case discussion the trainees will be given various radiological images (X-ray, CT, MRI, angiograms, etc. and investigations like ECG, ECHO, ABG, capnography, etc. to interpret clinically and discuss regarding them. Various equipments, drugs, fluids etc. will also be exhibited for discussion. At the end of the discussion, a grand viva will also be held.

Recommended Reading:

a. Books (latest editions)

1. Cottrell and Patel's Neuroanaesthesia, 6th Edition, 2016
2. Textbook of Neuroanesthesia and Neurocritical Care. Himanshu Prabhaker.2021
3. Essentials of PediatricNeuroanesthesia. Sulpicio G. Soriano.2018
4. Essentials of evidence-Based practice of neuroanaesthesia and neurocritical care. Himanshu Prabhaker.2021
5. Problem-Based Learning Discussions in Neuroanaesthesia and Neurocritical Care. 2020
6. Neuroanaesthesia: A Problem-Based Learning Approach
7. Fundamentals Of PediatricNeuroanaesthesia. GP Rath. 2021
8. Manual of Neuroanaesthesia. The Essentials. Himanshu Prabhaker. 1st Edition 2017
9. Gupta and Gelb's Essentials of Neuroanaesthesia and Neurointensive Care. Arun Gupta. 2nd Edition 2018
10. Miller's textbook of Anaesthesiology, 9th Edition
11. Steve Waldman 'Pain Management'

b.Journals:

S.No	Journal	Website
1	Journal of Neurosurgical Anaesthesiology	https://journals.lww.com/jnsa/pages/default.aspx)
2	Journal of Neuroanaesthesiology and Critical Care	https://www.thieme.in/journal-of-neuroanaesthesiology-and-critical-care)
	Neuromodulation: Technology at the Neural Interface	https://www.neuromodulation.com/journal
	World Neurosurgery	(https://www.sciencedirect.com/journal/world-neurosurgery
	Current Opinion in Anesthesiology	https://journals.lww.com/co-anesthesiology/pages/default.aspx
	British Journal of Anaesthesia	https://www.bjanaesthesia.org/
	Neurocritical Care	https://www.e-jnc.org

	Anaesthesia Analgesia	journals.lww.com/anesthesia analgesia/pages/default.a
	Journal of Neurosurgery, Spine and Pediatrics	https://thejns.org/
	Pain	https://journals.lww.com/pain/pages/default.aspx

c. **E resources:** https://snacc.org/
www.clinicalkey.com forAnaesthesia Critical Care & Pain Medicine
http://www.uptodate.com
https://bestpractice.bmj.com
https://www.thelancet.com

https://www.nejm.org

Program outcome for PDAF Neuroanaesthesiology and Neurocritical Care:

Outcomes of the 'PDAF Neuroanesthesiology', are outlined below and summarize the broad skill-sets that the candidate is expected to acquire after the successful completion of two years of training program:

- To assess and evaluate patients coming with various acquired and congenital neurosurgical as well as neurological conditions in a step-based systematic and orderly manner and perform a detailed pre-anesthetic assessment of such patients in order to assess the feasibility of these patients to undergo routine or elective neurosurgical procedures or neuroradiological interventions in presence of concomitant co-morbidities and associated morbidities, optimize these patients suitabily to a point where they can be posted for surgical/intervention radiological procedures.
- To apply the knowledge of pre-anaesthetic evaluation and investigations in the perioperative management of these patients undergoing neurosurgical/neuroradiological interventions.
- During the intraoperative/intraprocedural period, to apply sound scientific knowledge and skills for management of diverse intraoperative/ periprocedural situations and complications like management of difficult airway, dyselectrolytemia, acid-base imbalance, airway compromise, raised intracranial pressure, massive hemorrhage, air-embolism, physiological derangements due to positioning etc. which are unique to neurosurgical procedures and optimally manage them.
- Proficiency in advanced patient monitoring techniques like intracranial pressure, cardiac output, electroencephalography, evoked potential, transcranial Doppler, cerebral oximetry, jugular venous oximetry, microdialysis and echocardiography.
- Provide clinically sound and evidence-based management of postsurgical patients in the neurosurgical intensive care unit after they have undergone surgical/ radiological procedures to stabilize their clinical conditions and restore physiological and neurological homeostasis to a reasonable level from where they can be safely shifted to respective wards.
- Management of specific postoperative neurological complications, namely, vasospasm or rebleed after aneurysmal clipping, cerebral oedema, hydrocephalus, secondary systemic insults and post-cardiopulmonary resuscitation care.
- For those postoperative patients who mandate elective mechanical ventilation, provide them with appropriate ventilatory support and related critical care management to ensure reduction of ventilator dependency/ weaning / formal tracheostomy.
- Critical care management of unique neurological ailments like stroke (ischemic/ hemorrhagic), GBS, MG, seizure disorders, polymyositis
- Develop essential skills in conducting medical research and present them in scientific forums and publish in relevant peer-reviewed journals at local, national and international levels.
- Keep up to date with the latest advances in neurosciences and critically examine the available scientific evidence and apply them in patient management at **local, national and international level.**
- Make evidence-based decision-making a part of the learning process, and apply it logically in a cost-effective **country-centric manner tailored to the needs of this unique subset of patients.**

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- Apart from clinical work, prioritize thrust research areas at **institutional, state, national and international levels** and network to set up collaborative networking and workforces at these levels to enhance the **research milieu of the country.**
- Become effective communicators to patients, their family, colleagues, inter-departmental personnel, technicians, nursing staff, teachers and students from diverse backgrounds.
- Develop mentorship, leadership and networking qualities to help teach, train and impart clinical and research skills to future Neuroanesthesiologists in the **state and country.**

Course outcome for PDAF Neuroanesthesiology
At the end of the course, the PDAF student should acquire the following competencies under the three domains:

(A) Cognitive domain (Knowledge domain)

By the end of the course, the PDAF student should be able to demonstrate the following:

1. A detailed and comprehensiveunderstanding/knowledge about the general principles related to neuroanesthesia, basic neuroanatomy and neurophysiology, Respiratory physiology, Cardiovascular physiology, Renal physiology and acid base physiology.

2. Requisite physiological processes involved in the normal functioning of thebrain and their alterations in various diseases of the central nervous system. Have detailed understanding of the pharmacokinetics and pharmacodynamics of various anesthetic drugs (intravenous and inhalational) used in neurosurgical as well as neurocritical care with its relevance to brain and spinal cord, their mechanism of actions, adverse effects, drug interactions with recent scientific evidence. Antibiotic stewardship, anticonvulsants, antiparkinson drugs anticoagulants

3. In-depth theoretical knowledge about the pathological basis of neurologic diseases, neuroinfections, peripheral motor neuron disease, metabolic disorders, traumatic brain injury, brain death, cerebral vascular accidents, ischemic or hemorrhagic stroke, subarachnoid Hemorrhage etc.

4. To have a basic understanding and clinically relevant understanding of neuro imaging using modalities like X-ray, Ultrasonography, Digital Substantial Angiography, Computed Tomography and Magnetic Resonance Imaging.

5. To have an understanding of neuromonitoring modalities both basic and advanced including cerebral/spinal blood flow, oxygenation and metabolism. Also have an understanding of basic and advanced hemodynamic monitoring modalities for better management of the patient in the operation theatre and/or neurointensive care unit.

6. Should be able to write and conduct a research proposal related to Neuroanesthesiology
in accordance with guidelines of the Ethics Committee and critically evaluate published literature in medical journals.

7. Have adequate knowledge of Statistics to enable critical evaluation and analysis of new
literature.

8. Be well versed with different neuroanesthesia and neurocritical care guidelines and their implications at **local, national and international level.**

(B) Affective domain (Attitudes including Communication and Professionalism)

1. Should be able to function as a part of a team, develop an attitude of cooperation with colleagues, interact with the patient, and the clinician or other colleagues of other specialities to provide the best possible diagnosis or opinion.
2. Always adopt ethical principles and maintain proper etiquette in dealing with patients, relatives and other health personnel and to respect the rights of the patient including the right to information and second opinion.
3. Develop communication skills to word reports and professional opinion as well as to interact with patients, relatives, peers and paramedical staff, and for effective teaching.
4. To develop astute communication skills so as to be able to break bad news and persuade/ convince the relatives of brain-dead patients for organ donation.
5. Todemonstrate empathy and equality when dealing with individuals of special groups like pediatrics, elderly, pregnant and transgenders.
6. Should have the ability to discuss, deliberate, review and examine scientific data, prepare and deliver lectures/presentations, take part in seminars, CME's, panel discussions and get the skills to present the information gained to students and colleagues.
7. To inculcate a spirit of healthy competitiveness while participating in scientific deliberations/ poster/ paper presentations/ participation in quiz etc. at **local, state, national and international forums.**
8. Politeness and courteousness towards subordinates, technical and nursing staff even at the times of crisis.
9. Punctuality, sincerity and strong sense of work ethics.

(C) Psychomotor domain

At the end of the course, the student should have acquired following skills:

1. Exposure to a whole range of cranial and spinal surgical procedures, cranial and spine trauma, spinal instrumentation, peripheral nerve repair, ventriculo-peritoneal shunt insertion, movement disorders, and exposure to awake craniotomy. The student will

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be exposed to anaesthetic management of neurosurgical patients in neuroradiological suite, management of patients in neurosurgical (postoperative and other critical patients) and neurological intensive care units.

2. In operation theatre,the student will practice and hone the necessary skills of conventional airway management and use of advanced airway gadgets including video-laryngoscope, supraglottic airway devices, fiberoptic bronchoscope. In addition to this; different strategies of ventilation along with fluid, electrolyte and temperature management. Appropriate use of intraoperative monitoring modalities like BIS, entropy, TCD and advanced hemodynamic monitoring.
3. Management of neuroradiological procedures with special emphasis on anticoagulation and its reversal, contrast allergies and nephropathy, ischemic and hemorrhagic complications, management of hypothermia, deliberate hypotension and transient circulatory arrest. understanding of radiation safety and different zones of MRI.
4. Intensive care management of postsurgical patients especially those planned for postoperative mechanical ventilation. Management of other critically ill neurological patients like status epilepticus, encephalitis, meningitis, multiple sclerosis etc. with special emphasis on sepsis, shock, coagulopathy, ARDS, vasopressor management. Essential skill set comprising central venous catheterisation, intra-arterial cannulation, percutaneous tracheostomy, ICD placement, lumbar drain placement and bronchoscopy and video EEG. Use of ultrasonography in neurocritical care for assessment of fluid responsiveness, optic nerve sheath diameter, lung ultrasound, airway ultrasound and transthoracic echocardiography, color doppler to rule out DVT.
5. Use of newer and novel postsurgical analgesic therapies like scalp block, erector spinae plane block, thoracic inter fascial plane block and patient controlled analgesia.
6. Basic understanding of common interventional pain procedures (head & neck, spine) like trigeminal neuralgia, styloid neuralgia and failed back syndrome.
7. To develop optimal degree of confidence while performing these procedures.

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Neuro-Anaesthesiology

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