GUIDELINES FOR COMPETENCY BASED POSTGRADUATE TRAINING PROGRAMME FOR DM IN NEURORADIOLOGY

(Neuroimaging, Endovascular, Therapeutic and Interventional Neuroradiology {NIETINR})

Preamble

The last two decades have seen very rapid advances in medical technology and fundamental knowledge related to Neuroimaging, Endovascular, Therapeutic and Interventional Neuroradiology (**NIETINR**) with significant impact on early diagnosis and management of diseases of nervous system. These developments have also led to a more coordinated, multidisciplinary approach to management of critical neurological diseases and thus the need to establish proper training based on a set of guidelines & curriculum encompassing all components of the discipline such as Neuroimaging, Endovascular, Therapeutic and Interventional Neuroradiology (**NIETINR**) to complement, augment and provide definitive services related to clinical neurosciences which includes Neurology, Neurosurgery, Medical Neuro-oncology, Surgical Neuro-oncology, Radiation medicine, Nuclear medicine, Neuropathology, Neuro-virology, etc. relevant to Neurological disorders.

Goal

To train specialists in the superspecialty of Neuroradiology {Neuroimaging, Endovascular, Interventional and Therapeutic Neuroradiology (**NIETINR**)} after post-graduation (MD - Radiology, Radiodiagnosis or equivalent) leading to degree DM.

SUBJECT SPECIFIC OBJECTIVES

The DM course in Neuroradiology (Neuroimaging, Endovascular, Interventional and Therapeutic Neuroradiology (**NIETINR**) is targeted to develop specialists with clinical acumen and skills so as to enable them to function as experts in diagnostic Neuroimaging, Endovascular, Therapeutic and Interventional Neuroradiology (**NIETINR**). The students will undergo training in Neuro-Imaging, Endovascular, Therapeutic and neuro-interventional

procedures related to the brain, spine and spinal cord, head and neck, orbit and all orbital structures, supra-aortic vessels and organs of special senses in adults, children and infants. On completion of the course, the student would be able to deliver the highest quality of patient care, be a competent and inspiring teacher, and be able to pursue both clinical and experimental research. This will help country to develop required manpower to meet the rapidly increasing demand for this important area of the patient care, teaching and research, technology development, and to be self-reliant in materials and the equipment, thus helping all institutions in the country engaged in treatment and management of a wide variety of neurological diseases.

The students to the course must be exposed to the entire range of cases in neurological and neurosurgical (those requiring surgery as also those requiring management using interventional neuroradiological procedures) diseases. The student needs to perform meticulous history taking, thorough clinical examination, examine the necessary investigations required to reach the diagnosis, order diagnostic tests and perform imaging which he/she thinks are necessary for correct diagnosis and may be needed to perform interventional procedures, counsel and manage patients, and use the drugs and contrast based upon local institutional policy. They will also need to appropriately and rationally work with other departments to provide patient-focused care. The student should also know the various ethical issues involved in the management of the patients.

a. Primary Objectives:

a) Impart adequate holistic knowledge – both basic and applied aspects of Neuroimaging, Therapeutic and Interventional Neuroradiology **(NITINR)**

b) Provide hands on experience to develop necessary skills to perform imaging, therapeutic and interventional procedures as required in all neurological diseases

c) Train to integrate knowledge and skill for appropriate patient care, teaching and research in the field of Neuroimaging, Therapeutic & Interventional Neuroradiology.

b. Secondary objectives

a) To impart adequate knowledge (both basic and applied) to enable the student to develop desired level of competence to be able to effectively interact with

specialists in a wide range of other disciplines in medical colleges and other institutions, to deliver state of the art clinical care by multi-disciplinary patient care approach wherever required and effectively complement research

b) To develop as a competent dedicated teacher and good researcher

c) Develop ability to adapt to local conditions and demands

d) Develop skills for evidence based and ethical practices in line with hospital Ethics Committee guidelines.

- **Theoretical Knowledge**

The student must strive to gain sound theoretical knowledge. During the period of study, the student will work full time under the guidance of faculty with incremental clinical and practical responsibilities. The student will actively participate in seminars, journal reviews, conferences, and didactic lectures which shall form the core basis of training. The student will be rotated in departments of Neurosurgery, Neurology, Neuropathology and Neuro-anaesthesia to get acquainted with common clinical diagnostic and management practices. The training program is designed to encourage the student to participate in all activities of the department, and acquire necessary knowledge and skills to become a self-assured, competent and confident specialist, able to deliver the highest quality of patient care. After completing the course, the student should be able to deliver the highest quality of patient care, must be an inspiring teacher and able administrator. He/she must be capable of establishing and managing Department of Neuroradiology (Neuroimaging, Endovascular, Therapeutic and Interventional Neuroradiology-NIETINR) anywhere in the country and able to pursue both clinical and experimental research.

- **Practical and Clinical skills**

The objectives of the clinical training are:

1. To develop clinical judgment and technical skills in diagnosis and comprehensive management of patients with neurological diseases, to be able to provide excellent patient care, with various modalities of INR treatment alone or as a complement to other modalities.

2. To develop expertise in handling different kinds of medical emergencies arising either out of NIETINR procedures or other modes of therapy viz; a) seizures b) infections leading to respiratory distress/failure, renal insufficiency, hepatic insufficiency, and neurological disturbance, c) haemorrhagic complications, c) electrolyte disturbance, d) toxicities and emergencies.

3. To impart full knowledge concerning (i) Endovascular, therapeutic Interventional Neuroradiology including various endovascular therapies and materials used for it, biologics, drugs used, CT, angiography and MR contrast agents, and (ii) basic knowledge concerning gene therapy, immune therapy and their mechanism of action, side effects, mode of administration, interrelation with other drugs and their therapeutic effects, so as to be able to take appropriate clinical decision.

4. To acquire knowledge in Pediatric Neuro-Imaging and Endovascular Interventional Neuroradiology and radiation protection.

5. To acquire knowledge in Geriatric Neuroradiology including unique issues of diseases in old age, eg., Alzheimer's, dementia, vascular cognitive impairment disorders, extracranial and intracranial vascular lesions, and other degenerative diseases.

6. To acquire knowledge about all modern diagnostic imaging modalities including fusion imaging, ultrasound, DSA, CT, MR, SPECT, CT SPECT, PET, CT-PET, MRI-PET and radionuclide scans, handling of radioactive material and radiation protection. This is aimed for the student to gain confidence and expertise in procurement of machinery and equipment for the department and their appropriate use.

7. To make the student fully conversant with indications and application of electrolyte therapy, new antibiotics, antifungal and antiviral agents and other supportive measures.

8. To make the student fully conversant with and trained in various aspects of embolic material uses, intracranial and extracranial angioplasties (PTA), stenting, embolization of cerebral and spinal AVMs, aneurysms, Dural AVFs, Pial Fistulae, Vein of Galen malformations and other vascular lesions, schedule of treatment, indications for the use of various antiplatelet and anticoagulants, endovascular stroke interventions, prevention and management of various INR complications both acute and delayed.

9. To develop understanding of clinical trials (design, data collection, analysis and interpretation of related statistics), epidemiology, preventive and community services related to this discipline (such as imaging data collection, interpretation in cohort studies, collaboration in clinical epidemiological work requiring neuroimaging inputs as per syllabus requirement).

10. To make the student understand the psyche of his patients, which is often disturbed with the knowledge that he or she has a nervous system problem. The student will learn how to understand and address such psychological issues with compassion and temperate behavior and must learn good communication skills to convey critical and disquieting / disturbing information to the patients.

11. To make the student understand holistic management of acutely and terminally ill patients including palliative care measures. To make the student understand ethical, legal and economic issues including taking informed consent, research ethics, conflict of interest etc.

12. After completion of the course, if working as a faculty in a teaching Institution, the post graduate student must be an inspiring teacher and guide thesis writing and publish peer reviewed research articles.

13. To give the student orientation in community neuroradiology including preventive aspects, risk factors for vascular diseases affecting CNS (eg. stroke, degenerative diseases, cranial and spinal trauma and sequelae), preventive oncology, out-reach program for cancer awareness, tobacco cessation, and various health related screening programms and acceptance and integration of such patients into the society.

- **Teaching Skills**

The student should be exposed to the basic methodology of teaching and develop competence in teaching medical, paramedical and nursing students at the undergraduate and postgraduate levels. The student must acquire the skills to transfer his/her knowledge in a clear and succinct manner and be able to motivate students (when working as a teacher) to pursue further reading.

- **Research Skill - Writing research articles**

The students must gain basic skills and knowledge to function as investigators. The students should be exposed to state of the art basic, translational, and clinical research and through active participation; research skills needed to be acquired include:

  - developing appropriate scientific knowledge and critical evaluation of the relevant literature,
  - problem solving,
  - design and interpretation of experiments,
  - communication of progress and results in formal and informal settings,

- understanding national and international systems for funding of research and learn to obtain their own funding, and
- sharpen critical thinking,
- Scientific professionalism would be stressed in clinical situations,
- Basic knowledge of statistics, along with clinical epidemiologic principles like appropriate study designs, critical appraisal of data management and analysis.

- **Attitudes including interpersonal and communication skills**

The students should learn and practice communication skills through experience in counselling patients before imaging or intervention. The patients should be provided information about all imaging and interventional procedures, contrast reaction and possible complications of anaesthesia and interventions and how it may affect the overall outcome. In the CT, MR, or DSA room setting, they will learn the skill of working with different caregivers like anesthetists, nurses, technicians and other paramedical staff. The interventional procedures in DSA or CT room environment also will give them the training for handling crisis situations like contrast reaction, anaphylaxis, aneurysm or AVM bleed, massive blood loss in various conditions, air embolism, cardiac arrhythmias and cardiovascular collapse. The students will learn the importance of working as a team and will develop the skills of getting the best out of paramedical and nursing staff. In the intensive care set-up, they will learn to develop communication skills to deal with sick patients and their anxious relatives. Students will also learn the art of working together with colleagues from other specialties. By getting the opportunity to make presentations and attending the seminars, journal club and case presentations, students will also learn the art of making good presentation and teaching.

- **Training in Research Methodology**

The students will attend seminars and workshops to get acquainted with research methodology and writing research project for funding with appropriate research methodologies, acquire further information interacting with others involved in research.

SUBJECT SPECIFIC COMPETENCIES

Cognitive domain (Knowledge domain)

At the end of the course, the student should acquire knowledge competencies in the following broad areas:

1. Anatomy of the nervous system, musculo-skeletal and vascular system, as relevant to the CNS and PNS.
2. Basics in physiology of the nervous system, vascular system as relevant to the CNS, PNS and musculo-skeletal system.
3. Pathology of the diseases of nervous, vascular and musculo-skeletal systems.
4. Pharmacology of the drugs used in patient management in Neuroimaging and NIETINR
5. Physical principles of the imaging.
6. Clinical assessment, diagnosis and management as required for NIETINR.
7. Basic principles and applications of biostatistics

Affective domain (Attitudes including Communication and Professionalism)

It is important that a student must acquire the attributes of interpersonal relation, good communication skills, professionalism and medical ethics in his/her practice.

By the end of the course, the student:

1. Should be able to function as a part of a team, develop an attitude of cooperation with colleagues, and interact with the patient and the clinician or other colleagues to provide the best possible diagnosis or opinion.
2. Always adopt ethical principles and maintain proper etiquette in dealings 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. **Ethics:** The medical profession has long subscribed to a code of ethics developed primarily for the benefit of the patient. A physician must recognize responsibility to patients first and foremost, as well as to society, to other health

professionals, and to self and adhere to the Ethical Guidelines enunciated by the Medical Council of India.

Psychomotor Domain

At the end of the course, the student should be able to perform independently the following techniques/procedures:

1. **US and Doppler** facility, CT and MRI and fusion imaging: Learn operational protocol of machines and imaging modalities, interpretation and reporting of computed tomography and MRI scans for all cranio-spinal nonvascular (traumatic, developmental, infective, inflammatory, immunological, degenerative diseases etc.) and all vascular diseases of the CNS.
2. **Neurovascular Bi-plane Digital Subtraction Angiography lab**.: Learning invasive diagnostic procedures like aortography, cerebral and spinal angiography, myelography, and other procedure as per syllabus and training in Endovascular, Therapeutic and Interventional neuroradiological procedures as per details given in the syllabus independently but under supervision.
3. Training and later independent hands-on experience in the following procedures:

    - Diagnostic cerebral and spinal angiography
    - Cerebral angiography for gamma knife planning and stereotaxic neurosurgical procedures
    - Thrombolysis in acute stroke
    - Transarterial particulate embolization of tumors of the head and neck.
    - Transarterial liquid and direct puncture liquid embolization of cranio-facial and spinal vascular malformations
    - Percutaneous transluminal angioplasty procedures
    - Water soluble myelography and CT myelography
    - Percutaneous biopsy of the spinal pathologies
    - MR Imaging including functional MRI and Intra-operative MRI
    - Imaging for image guided surgeries such as deep brain stimulation (DBS) etc.
    - Ultrasound and Doppler Imaging
    - Digital radiography
    - Picture archiving and communication system (PACS), RIS and HIS
    - Research activities in collaboration with other departments
    - Short term observer posting in department of Neuroradiology in any other reputed institution in the country if so mandated by parent institution.

- Help the physician/surgeon in choosing the right investigation/ interventional procedure by routine interactions.
- Manage the patient post-procedures.
- Handle neurological emergencies arising in Imaging and Therapeutic INR suites.
- Interpret radiological examinations of body systems other than CNS as well.
- Emergency management of patients with head injury, spinal injury, raised intracranial tension, subarachnoid hemorrhage and strokes requiring neuro radiologic evaluations. The student will be required to have a thorough knowledge of such emergency procedures and be able to respond intelligently and quickly to these needs.
- Radiation protection and safe handling of radioactive material.

Syllabus

Course contents:

During the course, the student should be imparted and acquire learning in the following specific knowledge domains:

A. Anatomy

1. Basic neuro- and vascular anatomy
2. Embryology of the nervous system, brain, spinal cord and peripheral nervous system
3. Embryology of the vascular system as relevant to the nervous system
4. Anatomy of the vascular system in general with special emphasis on blood supply to the brain and spinal cord and functional vascular anatomy of CNS.
5. Anatomy of the brain and spinal cord, peripheral nervous system
6. Embryology and anatomy of the spine
7. Embryology and anatomy of the skull and face.
8. Anatomy of musculo-skeletal system in relation to CNS and PNS.

B. Physiology

1. Basic and applied neuro- and vascular physiology including cardiac hemodynamics, ECG, EEG.
2. Physiology of nerve conduction, cerebral and spinal blood circulation,
3. Basics of physiology of nervous system
4. Basics of physiology of peripheral vascular system.
5. Physiology of cerebral circulation
6. Physiology of cerebrospinal fluid
7. CSF dynamics and functional inter-relationship of CNS haemodynamics and hydrodynamics.

8. Basic and applied neurophysiology including cardiac haemodynamics.

C. Pathology

1. Pathological basis of neurological and vascular disorders
2. Congenital lesions of the central nervous system – brain, spine and spinal cord and organs of special senses
3. Neoplastic disease of the head and neck, skull base including pathologies of temporal bone and orbit
4. Neoplastic diseases of the brain, spine and its coverings.
5. Infective and inflammatory lesion of the CNS
6. Degenerative and demyelinating diseases of the CNS
7. Vascular and ischaemic lesions of brain and spine.
8. Intracranial aneurysms and AVMs
9. Intracranial hemorrhage
10. Hydrocephalus
11. Cerebral edema
12. Congenital malformations of CNS
13. Neonatal and perinatal CNS disorders
14. Genetic and inherited disorders of CNS
15. Metabolic and Immunologic disorders affecting CNS
16. Arteritic and related diseases
17. Miscellaneous

D. Neuro-chemistry and Neuro-pharmacology

1. Contrast media in imaging
2. Emergency drugs in Neuroimaging and Interventional Therapeutic Neuroradiology
3. Antiplatelets and anticoagulants
4. Vasodilators
5. Vasoconstrictors
6. Embolic agents
7. Thrombolytic agents
8. Anaesthetic and analgesic drugs with respect to neuro-imaging and neuro-intervention
9. Antibiotics
10. Anti-inflammatory drugs
11. Cortico-steroids
12. Drugs to counter cerebral edema
13. Drugs to control hypertension
14. Drugs for renal diseases
15. Drugs used in Neurointervention and Therapeutic Neuroradiology

E. Physical principles of imaging

1. Image intensifier and TV and Flat Panel Detectors

2. Tomography
3. Angiography and Digital subtraction and angiography
4. Computed Tomography and recent advancements in CT
5. Ultrasound and Doppler and their recent advances
6. Magnetic Resonance Imaging, angiography, spectroscopy, FMRI (Diffusion, Perfusion), molecular imaging and recent advances
7. Film processing techniques – wet and dry
8. Principles of single photon emission and positron emission tomography (SPECT and PET)
9. Fusion Imaging technologies –SPECT, CT PET, MR PET etc.
10. Basics of Nuclear Medicine and safe handling of radioactive material.
11. Radiation protection and Recommendations of Atomic Energy Regulatory Board
12. Computers in Radiology
13. Picture archival and communication systems and Teleradiology
14. New image storage technologies, CLOUD storage systems

F. Therapeutic and Interventional Neuro-radiology

1. Endovascular recanalization / revascularization techniques.
2. Drugs and materials used in endovascular, interventional neuroradiology
3. Embolization Techniques
4. Embolization of CNS lesions.
5. Embolization of craniofacial lesions
6. Interventions in spinal vascular lesions.
7. Thrombolytic therapy in CNS lesions,
8. Spinal interventions –
    a. Chemonucleolysis
    b. PLDD (Percutaneous Laser disc decompression),
    c. Vertebroplasty,
    d. Kyphoplasty,
    e. Percutaneous Biopsy.
    f. Others – Facet Joint Injections etc.
9. Atreriovenous Malformations (AVM) and Fistulae (AVF): Natural History, aetiopathogenesis, clinical features, Imaging and management.
10. Dural Arteriovenous Malformation (DAVFs): Natural History, aetiopathogenesis, clinical features, Imaging and management.
11. Carotico cavernous Fistula (CCF): Aetiopathogenesis, natural history, clinical features and management.
12. Spinal Vascular Malformations: Natural History, aetiopathogenesis, clinical features, Imaging and management.
13. Embolization of vascular lesions of head and neck and spine: meningiomas, juvenile angiofibromas, paragangliomas, tumors of vertebral bodies etc.
14. Intracranial Aneurysms: Natural History, aetiopathogenesis, clinical features, Imaging and Endovascular management.

15. PTA and stenting of the intracranial vessels.
16. Vein of Galen aneurysmal malformations: Natural history, aetiopathogenesis, clinical features, Imaging and Endovascular management
17. Management of Post SAH vasospasm/ vascular spasm of the CNS vessels due to other causes
18. Management of acute ischemic stroke and related issues
19. Management of dural sinus thrombosis
20. Complications in Interventional and Therapeutic Neuroradiological procedures and their management
21. Tools and devices for Therapeutic and Interventional Neuroradiology
22. Pre-procedure and post-procedure care of patient
23. Techniques in Therapeutic and Interventional Neuroradiology
24. Pharmacology as applied to Therapeutic and Interventional Neuroradiology
25. Managements of AVFs and acute traumatic CNS vascular lesions
26. Stereotactic Radiotherapy in AVMs and DAVFs- concepts and indications
27. Chemotherapy for cranial and orbital malignancies
28. Wada Testing
29. Temporary Balloon Occlusion test (BTO) of cerebral vessels
30. Permanent Balloon Occlusion of cerebral vessels
31. Traumatic lesions of supra-aortic vessels
32. Inferior petrosal sinus sampling
33. Intracranial arterial thrombolysis / embolectomy and venous thrombolysis
34. Percutaneous treatment of herniated disc
35. Nerve blocks
36. Intra-vascular ultrasound

G. Imaging in disorders of brain, spinal cord, orbit, base of skull, head and neck, otorhinology

1. Disorders of brain development
2. CNS manifestations of phakomatoses and other inherited syndromes
3. Epilepsy
4. White matter disorders and inherited metabolic disorders
5. Intra-axial brain tumors
6. Extra-axial brain tumors
7. Intracranial haemorrhage
8. Intracranial vascular malformations and aneurysms
9. Cerebral ischaemia and infarction
10. MR Angiography techniques and clinical applications
11. Head trauma
12. Intracranial infection / inflammation
13. Metabolic and immunological disorders of CNS
14. Genetic and hereditary disorders of CNS
15. Normal ageing, dementia and neurodegenerative disorders
16. The skull base

17. Sella turcica and parasellar region
18. Anatomy and diseases of temporal bone
19. Eye, orbit and visual system
20. Paranasal sinuses, temporal bone
21. Congenital anomalies of spine and spinal cord: embryology and malformations
22. Degenerative disease of spine
23. Neoplastic diseases of spine and spinal cord
24. Spinal trauma
25. Vascular disorders of spine and spinal cord
26. Spinal infections and inflammatory disorders
27. Anatomy and pathologies of Head and Neck diseases

TEACHING AND LEARNING METHODS

a) Journal Club:

One hour duration: The trainee shall present weekly/or as per schedule Journal articles presentation in the academic forum over the 3 year period.

Paper presentation/discussion: once per week. The student should present at least two articles along with relevant case report, either an original article (Randomized Controlled Trial/Systematic review) or a short study along with a review article, relevant to **NIETINR,** citing the relevance, background/context, study methods and statistical analysis, interpret the results and discuss, summarize, present limitations of the study and critically analyze the study methods and outcomes.

b). Subject Seminar:

The student should make specified number of presentations on various topics over the three years period in the Departmental / Institutional academic Forum.

One seminar every month of one hour duration (morning or afternoon). The trainee will present a subject topic allocated after doing a comprehensive preparation, relevant literature search and present the topic in detail covering all the relevant aspects, clinical applications and engage audience and answers questions.

The soft copy of all academic presentations should be stored in CD and submitted during final examination, as record.

c). Didactic Lecture/discussion:

Lectures may be held on new topics by faculty, in place of seminar, as per need. Invited didactic lectures on basic neurosciences, biostatistics, research methodology, teaching methodology, from external faculty of specialties related to the subject, medical ethics and legal issues related to **NITINR**, and neurotrauma, neurointensive care practice, patient care and patient management should be conducted once or twice a week.

d) Clinical Case presentation / Case conference in the ward and the afternoon special clinic should be in place every week with the current final year students presenting the case (in rotation) and remaining students will follow in the coming years (when the 2nd year PG will take up that position). This should be horizontally integrated with all related clinical disciplines. The roster for the same will be prepared for the year with all details.

The trainee should critically analyze at least 2 case records noting details such as treatment delay/non-compliance/diagnostic dilemma/atypical presentation/Co-morbidity / treatment sequence/treatment interruption/etc. that has played a role in the outcome of that particular patient and what is the possible solution/intervention required for a favorable outcome, for similar patients in future.

The students must work up one long case and three short cases and present the same to a faculty member and discuss the management. The student will present a clinical case for discussion before faculty and discuss its management and decision to be recorded in case files. The student will present a clinical case, either from neuroimaging on diagnostic point of view or some Endovascular, Interventional and Therapeutic Neuroradiology case, after performing thorough history and physical examination, elicit all physical signs, formulate diagnosis/differential diagnosis and able to plan a comprehensive care plan for the patient.

The schedule of activities is given below:

Day	Duration	Activity
Monday	1 hour	Journal Club
Tuesday	1 hour	Didactic Lecture
Wednesday	1 hour	Subject Seminar
Friday	1 hour	Clinical Case Presentation

On Thursday and Saturday, academic programme can be planned as per requirement and need. However, timing of teaching and days of teaching would entirely depend upon the local arrangement at the teaching institute. Morning time will be the most suitable for class room sessions.

e). **Clinico/radiology/pathological Conference:** Special emphasis should be given on the clinic/radiology/pathology correlation. Such exercises help the Neuroradiology/ neurology/neurosurgery/Pathology/PG students.

f). **Combined Round/Grand Round:** must be done once a week or twice a month involving presentation of unusual or difficult cases. The student would attend Hospital Grand Rounds weekly, involving presentations from anaesthesia, neuroanaesthesia, neurosurgery, neurology and intensive care unit. If core lectures are arranged at the beginning of the course from the teaching departments in the hospital the residents must be permitted to attend.

g). **Emergency/Casualty Posting:** Casualty duty to be arranged by rotation among the PGs with a faculty cover daily by rotation.

h). **Bedside clinical training/teaching for patient care management**. Daily, bed side patient care discussions are to be made for ½ to one hour during ward round with faculty and 1-2 hours in the evening by senior resident/faculty on emergency duty. **Clinical teaching:** In OPD, ward rounds, emergency, ICU and the operation theatres.

i). DSA lab discussion - All postgraduate students posted in DSA lab and Interventional Neuroradiology will carry out their clinical work under supervision of faculty. This would involve around 1hour of teaching by faculty.

j). PG students shall be required to participate in the teaching and training programme of Undergraduate students and interns.

k). Hypothetical Trial Design: Students should outline at least 2 hypothetical clinical trial design for practice.

l). Core Training:

Both learning and teaching should be integral part of the programme and includes:

- Diagnostic radiology case work up - Neuroimaging, Endovascular, Interventional and Therapeutic Neuroradiology and Intensive Care rounds and hands-on training and teaching in the CT, MRI and DSA room should be the mainstay of the teaching programme, rather than didactic lectures.
- Journal Club meetings should be held once a week
- Department should encourage e-learning activities
- A Case conference: Diagnostic and Intervention, mortality/morbidity review and departmental audit should be held at least bimonthly to review all difficult cases of diagnosis and intervention, and deaths/complications attributed to procedure, if any.
- Unscheduled and informal discussions to be held as often as possible depending upon the variety and the number of procedures seen and done.
- Students should be encouraged to undertake epidemiological and /or clinical research programme on selected topic and taught basic research methodology and reporting.
- The postgraduate student should have a minimum of one publication in indexed national/international journals during the three year course.
- CME Credit: The student should earn at least 30 hours of credit over the 3 years period by attending conferences/symposium/institutional/Web based CME programmes. The students should be encouraged to deliver lectures/ present papers at the CME programmes conducted at the national, state and local levels to boost their confidence.
- The student should submit at least one scientific paper per year related to Neuroimaging, Endovascular, Interventional and Therapeutic Neuroradiology

(NIETINR), and neurotrauma. The student must attend various annual conferences of the national and international societies.

m). Log book:

Log book serves as a document of the trainee's work. The trainee shall maintain Log book of the special procedures/ operations performed by him / her during the training period right from the point of entry and its authenticity should be regularly assessed by the faculty and certified by the concerned Postgraduate Teacher/Head of the Department. This shall be made available to the Board of Examiners for their perusal at the time of his / her appearing at the final exit Examination. The log book should record diagnostic and interventional cases (all done in US, CT, MRI and in the interventional neuroradiological/radiological DSA lab) seen and presented, procedures performed, seminars, journal club and other (case) presentations. Log book entries must be qualitative and not merely quantitative, focusing on learning points and recent advances in the area. It should also contain detailed documentation of a minimum of 5 interesting cases.

n). Research

A student shall be required to present at least one paper/one poster at conferences of state, national or international levels. The work must also be published or at least sent for publication in an Indexed journal before the completion of course. Publication in an indexed journal is desirable as the University would be considering, that also in case it decides to provide awards to the best student.

Clinical Posting Recommended Time Schedule during three years of training:

Time schedule during three years of training:

The student will work full time in the department of Neuroimaging, Therapeutic and Interventional Neuroradiology with full clinical responsibilities. Basic orientation in Neuroimaging and vascular radiology would be provided in the first year. The student would be posted by rotation to the Departments of Neurology,

Neurosurgery, Neuro-anaesthesia, and Neuropathology for 1-4 weeks each, as per institutional provisions during the three year period.

Year 1:

First six months to one year

Orientation in all areas. The first year of the programme would be spent in acquiring:

i). Basic skills in performing safely all non-invasive neuro- and vascular radiological, procedures, like computed tomography, MRI and sonography.

ii). Basic concepts of basic neuro- and vascular sciences including, neuro- and vascular anatomy, neuro- and vascular physiology, neuro- and vascular pathology, neuro- and vascular pharmacology as well as physical principles of diagnostic imaging including radiography, nuclear medicine and tomography, MRI, digital angiography, ultrasound and Doppler, metabolic imaging and application of computers in imaging sciences.

Year 2 and 3

The second year should be spent in:

- further refining the skills acquired in the first year.
- training under supervision in invasive neuro- and vascular radiology.
- research activities as per institutional guidelines.

- **Postings**

  i. **Out patients department posting under supervision of Consultants – 16 to 18 weeks**; To get exposure to major areas e.g. brain, ophthalmological problems, spinal problems, Head and Neck, Vascular problems, Pediatric, Pain and Palliative/Rehabilitation Clinic etc. During these clinics – trainee must learn concept of comprehensive, multimodality management of various diseases. He/she should be exposed right from beginning to make a diagnosis, do staging investigations, and plan a treatment and follow-up after completion of treatment. Training in radiation protection and safe handling of radioactive material is essential.

ii. Ward posting Six months along with DSA lab posting and six months exclusive posting in interventional neuroradiology work.

This may vary from 8 to 12 months along with other postings. The student may be allotted certain beds and he is required to work up patients admitted on those beds. He shall plan out diagnostic work up and treatment plan, discuss same with the concerned consultants, present it on the rounds and assume complete responsibility of the patients during their hospital course. He/she should work in harmony with the ward nurses.

iii. Elective posting: Six weeks in the area of research activity of student. The student selects the area of his or her interest; it may be training within the institute or at other specialized centers within. The student is required to seek acceptance from the concerned departments/centre where he wishes to work and also permission from the hospital administration/Dean.

The third year should be spent in:

- acquiring specialized skills in interventional neuro- and vascular radiological procedures
- participate in decision-making on management of the patients, execution and post-procedure management under faculty guidance.
- In the last six months of 3rd year, student will perform select neuro-interventional procedures independently and under faculty supervision.
- Student will be posted to the departments of Neurology and Neurosurgery and continue the work of second year.

Ancillary postings: for total 4 months as follows:

- Neurosurgery including Stereotactic Radiotherapy: 4- 6weeks.
- Neurology: 4- 6 weeks
- Anesthesia: 2 weeks + during neurosurgery posting

- Pathology: 2 weeks + student has to attend all pathology cases and brain cutting sessions.

  The student, apart from understanding the value of laboratory tests in a given lesion must possess the basic knowledge of interpreting the laboratory data and correlating it with clinical data. For this purpose, student is posted in various laboratories through laboratory posting or dissertation topic.
- Other posting if needed will be decided
- Preparatory leave: 1 month before final exam

A total of 12 months or more posting in the DSA lab with pre-procedure work up and post-procedure care in ward and ICU, as per institutional practice in three years of the course.

During the training programme, patient safety is of paramount importance; therefore, skills are to be learnt initially on the models, later to be performed under supervision followed by performing independently; for this purpose, provision of skills laboratories in medical colleges is mandatory.

ASSESSMENT

Formative assessment should be continual and should assess medical knowledge, patient care, procedural & academic skills, interpersonal skills, professionalism, self directed learning and ability to practice in the system.

General Principles

Internal Assessment should be frequent, cover all domains of learning and used to provide feedback to improve learning; it should also cover professionalism and communication skills.

Quarterly assessment during the DM training should be based on:

1. Journal based / recent advances learning

2. Patient based /Laboratory or Skill based learning
3. Self directed learning and teaching
4. Departmental and interdepartmental learning activity
5. External and Outreach Activities / CMEs

The student is to be assessed periodically as per categories listed in postgraduate student appraisal form (Annexure I).

SUMMATIVE ASSESSMENT ie., assessment at the end of training

The summative examination would be carried out as per the Rules given in **POSTGRADUATE MEDICAL EDUCATION REGULATIONS, 2000.**

The summative assessment examination shall include two heads:

A. Theory examination.
B. Practical, Clinical examination and Viva-voce.

Theory examination and Practical/Clinical, Viva-voce shall be separate heads of passing.

Theory examination shall comprise of four papers. Passing percentage shall be cumulatively 50% with minimum of 40% marks in each theory paper.

Practical /Clinical examination consisting of at least one long case, three short cases and viva-voce. Passing percentage shall be 50%.

Passing shall be separate for each head and failing shall be common, meaning thereby that clearance at theory and failure at practical / clinical shall amount to failure at Summative examination and vice versa.

The Post Graduate examination shall be in two parts: -

A. Theory

There shall be **4 theory papers** of 3 hours each.

Paper I: Basic Sciences as applied to the subject including Imaging Physics, Biochemistry, Pathology, Pharmacology, epidemiology, Clinical trials

Paper II: All aspects of Neuroimaging, Therapeutic and Interventional Neuroradiology- clinical and applied

Paper III: Therapeutic and Interventional Neuroradiology

Paper IV: Recent advances in Neuroimaging

B. Clinical/Practical and Oral examination:

Clinical/Practical Examination:

The practical examination shall include evaluation of 01 long and 03 short cases and demonstration of skills of clinical in evaluation and execution of at least one neuroradiologic procedure to reach a diagnosis.

Oral Examination:

i. Oral examination shall be exhaustive and every effort should be made to evaluate the student for his knowledge of neuroradiology including instrumentation, techniques and current concepts and future trends in clinical Neuroradiology.

ii. This examination also should include evaluation of the students' knowledge in application of Neuroanatomy, Neuro-pathology, Neuro-chemistry and Neuro-immunology relevant to clinical neuroradiology.

iii. Discussion on research work carried out by the student and related presentations and publications should be included in the viva-voce.

Recommended Reading material:

Books (latest edition)

Diagnostic Neuroradiology

1. Osborn's Brain: Imaging, Pathology, and Anatomy, Anne G. Osborn.
2. Diagnostic imaging brain: Osborn, Salzman and Barkovich.
3. Atlas of regional anatomy of the brain using mri with functional correlations: J.C.Tamraz, Y.G.Comair.
4. Pediatric neuroimaging: A. James Barkovich
5. Magnetic resonance imaging of the brain and spine: Atlas, Scott W.
6. Head and Neck Imaging: Peter M Som and Hugh D. Curtin
7. Caffey's Pediatric Diagnostic Imaging: Brain D. Coley
8. Pediatric Neuroradiology (Brain, Head and Neck and Spine: Paolo Tortori-Donati and Andrea Rossi
9. Magnetic Resonance of Myelination and Myelin Disorders: Marjo S van dar Knaap.
10. Functional MRI Basic Principles and Clinical Applications: Scott H. Faro, MD
11. Text book of Neuroradiology: 2 volumes

Physics

1. MRI The Basics: Ray H hashemi, William G. Bradley
2. MRI in Practice: Catherine Westbroook and Carolyn Kaut.
3. Susceptibility Weighted Imaging in MRI Basic Concepts and Clinical Applications: Haacke, Mark E. / Reichenbach, Jürgen
4. Radiology and Imaging Physics
5. PACS and IT in imaging

Intervention

1. Surgical neuroangiography VoL –I, II and III: P. Lasjaunias, A. Berenstein and K.G. Ter Brugge.
2. Practical Neuroangiography: Pearse Morris.
3. Tutorials in Endovascular Neurosurgery and Interventional Neuroradiology: James Vincent Byrne (Springer).
4. Textbook of interventional neurology: Adnan I. Qureshi
5. Interventional Neuroradiology: Robert W Hurst and Robert H. Rosenwasser. Informa healthcare.
6. Cerebral angiography (normal anatomy and vascular pathology): Gianni Boris Bradac (Springer)
7. Diagnostic Cerebral angiography: Anne G Osborn (Lippincott William and Wilkins)

Journals

3-5 International and two national (all indexed) journals.

Appendix

List of procedures (nos) to be carried out independently or under supervision by the students during 3 years of the senior residency:

1.	**Neuro-imaging**		
	i.	Ultrasound	
	a.	Neurosonography	50
	b.	Transcranial Doppler	50
	c.	Carotid Doppler	100
ii.	**CT**		
	a.	Cranial and spinal CT	500
	b.	Temporal bone imaging	50
	c.	Imaging of air sinus	50
	d.	Orbit	100
	e.	Head and neck	75
iii.	**MR**		
	a.	Cranial	500
	b.	Spinal	500
	c.	Head and neck, temporal bone, orbit	100
	d.	Examination by fast and new sequence	300
	e.	MR angio	100
	f.	CV junction	50
iv.	**Digital subtraction angiogram**		
	a.	Four vessel angiogram	300
	b.	Spinal angiogram	25
	c.	Aortogram, Head neck angiography	200
	d.	Super selective angiogram	50
2.	**Neurointervention**		
	a.	Minor vascular interventions	10
	b.	Assist major vascular interventions	50 (to assist and under supervision)

Annexure I

Postgraduate Student Appraisal Form

Name of the Department/Unit :

Name of the PG Student :

Period of Training : FROM……TO……

Sr. No.	PARTICULARS	Not Satisfactory	Satisfactory	More Than Satisfactory	Remarks
		1 2 3	4 5 6	7 8 9	
1.	Journal based / recent advances learning				
2.	Patient based /Laboratory or Skill based learning				
3.	Self directed learning and teaching				
4.	Departmental and interdepartmental learning activity				
5.	External and Outreach Activities / CMEs				
6.	Thesis / Research work				
7.	Log Book Maintenance				

Publications **Yes/ No**

Remarks*_____
_____
_____

***REMARKS: Any significant positive or negative attributes of a postgraduate student to be mentioned. For score less than 4 in any category, remediation must be suggested. Individual feedback to postgraduate student is strongly recommended.**

SIGNATURE OF ASSESSEE **SIGNATURE OF CONSULTANT** **SIGNATURE OF HOD**