

**DM Neuroimaging and Interventional**  
**Neuroradiology**  
**program**

Department of Imaging Science and  
Interventional Radiology

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## 1.1 General Programme Aims

The knowledge and practice of Neuroradiology comprise both imaging and interventional procedures related to the brain, head and neck, spine and spinal cord, and organs of special sense in adults and children. Special training and skills are required to enable the Neuroradiologist to function as expert diagnostic - therapeutic consultant, practitioner, teacher and researcher. The goal of the DM program is to provide the senior residents with an organized, comprehensive, and supervised full-time educational experience in the selection, interpretations, and performance of neuroradiologic imaging and interventional procedures.

### Guiding principles

The following six core competencies will be the guiding principles of this programme

#### **A. Medical Knowledge**

1. Acquire general medical knowledge and practice-specific knowledge
2. Know and critically evaluate current medical information
3. Understand and incorporate evidence-based decision-making

#### **B. Patient Care**

1. Medical interview and physical exam
2. Synthesis of clinical data, performance skills

#### **C. Interpersonal and Communication Skills**

1. Communicate effectively with other professionals and team members
2. Maintain comprehensive, legible medical records

#### **D. Professionalism**

1. Demonstrate self-awareness and knowledge of limits
2. Demonstrate high standards of ethical and moral behavior

3. Demonstrate reliability and responsibility
4. Demonstrate respect for patient's dignity and autonomy

**E. *Practice-Based Learning and Improvement***

1. Engage in ongoing learning to improve knowledge and skills
2. Analyze one's practice to recognize strengths and deficiencies
3. Seek input to improve practice and quality care

**F. *Systems-Based Practice***

1. Promote patient safety within the system
2. Provide value added and cost-effective care for patients
3. Promote health and prevention of disease and injury
4. Demonstrate effective practice management

## 1.2 Specific Objectives

### **Diagnostic Neuroradiology**

1. Provide clear, concise, and informative reports that are clinically relevant. Senior residents will notify referring clinicians of urgent and emergent findings in a timely fashion and document appropriately.
2. Become proficient in the use of picture archiving computer systems (PACS), online clinical document system, and other computer based modalities like voice recognition dictation systems.

3. Demonstrate professional behavior at all times, adhering to ethical principles and demonstrating sensitivity. Senior Residents will be cognizant and respectful of patient confidentiality.
4. Critically evaluate the scientific literature and apply it to daily practice and develop good habits of continuing medical education.
5. Play an active role in teaching of students, peers, and other members of the health care team.
6. Comply with the requirements of the Indian Medical Council, ICMR and Drug Controller of India and other relevant guidelines like Health Insurance Portability and Accountability Act (HIPAA) and FDA

### **Interventional Neuroradiology**

The majority of learning during the interventional radiology training is practice based. That is most of the learning will center around specific cases and patients. This involves the pre-operative patient assessment and work-up, technical aspects of the actual procedure, post procedure patient care, communication with referring physicians, and documentation skills. All these elements are critical to good practice.

Six general competencies that cover all these skills are mentioned below. All residents are expected to learn these skills during the course of their training. Although each area of competency is separated for descriptive purposes, in actuality, they are less discrete.

#### **At the end of his/her three year training each resident,**

1. Should be well acquainted with the current literature on relevant aspects of the basic, investigative, clinical and interventional neurosciences.
2. Should have acquired performance skills and ability to interpret relevant clinical investigations.

3. Should be able to diagnose, plan investigations and treat common conditions in the specialty by relevant current therapeutic methods.
4. Should have learned indications and performance skills of common Neurointerventional procedures.
5. Should be acquainted with allied and general clinical disciplines to ensure appropriate and timely referral.
6. Should be capable of imparting basic neuroradiological teaching, training and research.

The three year program consists of fundamental clinical evaluation, neurodiagnostic and interventional training and research to allow for acquisition of graduated experience in all aspects of Neuroradiology. Neuro-critical care experience is also emphasized and there is extensive exposure to subspecialty services including, neurovascular, neurooncology, head and neck radiology and pediatric neuroradiology.

Preparation of scientific manuscripts, review articles, book chapters and abstracts, along with presentation skills are fostered with multi-disciplinary input and mentorship. Leadership and administrative skills are learned as senior residents progress in their training and are honed during the final year. Routine academic activities will also include journal club, neuroradiology conference, clinical case discussions and multi-disciplinary clinicopathological conferences. Residents will also be encouraged to present papers at various scientific forums both at regional ,national and international levels.

Details of skills to be acquired in Diagnostic and Interventional Neuroradiology and allied sciences.

**Medical knowledge:**

- Demonstrate detailed knowledge of gross anatomy and embryology of the brain and spine.
  - Demonstrate in depth knowledge of sinus, facial bone, orbit, temporal bone, and skull base anatomy.
  - Discuss the compartments of the head and neck, their major components, and most common pathology.
  - Demonstrate proficiency in recognition of pathology and making differential diagnoses.
  - Be familiar of MRI, CT, Doppler USG and Nuclear medicine (PET) studies of the head and neck.
  - Demonstrate proficiency in the performance and interpretation of myelograms and cisternograms including CT Myelo/ Cisternograms.
  - Demonstrate understanding of MR sequences and advanced techniques such as MRS, MR perfusion, fMRI, and DTI.
  - Demonstrate proficiency in interpreting CTA and CT perfusion.
  - Demonstrate familiarity with 3D imaging.
- Develop thorough knowledge of the physical and physiological properties of contrast agents used in CT and MR; including contraindications and management of potential complications.
- Develop skills in identifying indications and risks and actual preparation and performance of angiography, endo-vascular neurointerventional procedures like aneurysm coiling, AVM and Dural AV fistula embolization, Carotid and intracranial angioplasty and stenting, intra-arterial thrombolysis and other procedures like vertebroplasty, image guided biopsy, and similar common neurointerventional procedures.
- Discuss modifications of studies based on expected and unexpected pathology.

- Demonstrate a thorough knowledge of the vascular anatomy of the CNS and pathology as demonstrated by angiography.
- Demonstrate proficiency in the performance of catheterization of the aorta, spinal arteries, and major cerebral vessels.
- Demonstrate proficiency in the performance of vascular and non-vascular neurointerventions.
- Have exposure to intra-arterial treatment of acute stroke.

**Patient care:**

- Screen, protocol, and supervise neuroimaging procedures. Be able to modify imaging protocols based on identification of unexpected or novel findings.
- Supervise and screen patients for contrast administration especially for power injections. When appropriate, screen for non- use of contrast in consultation with the referring physicians or when essential, consent is obtained for Nephrogenic Systemic Fibrosis/other adverse effects in high risk patient population.
- Supervise and screen patients for MR safety.
- Be able to evaluate patients for sedation and obtain informed consent.
- Learn the clinical and imaging indications for acute stroke intervention including intra-arterial thrombolysis.
- Perform prioritization and triage for neuroradiologic emergencies.
- Make decisions to modify a procedure when unexpected pathology or abnormalities occur, then follow through with the performance and supervision of the procedure.

- Make decisions in the treatment of acute stroke patients in consensus with the referring physicians.
- Make clinical decisions based on patients' condition when consulting with the patient, pre- or post – procedure.
- Write pre- and post – procedure orders.
- Be able to evaluate the clinical status of patients prior to, during and after the procedure.

Learn to recognize complications of these procedures and to initiate appropriate treatment.

### **Communication Skills**

- Effectively obtain informed consent for procedures and sedation.
- Articulately review studies with referring physicians.
- Guide clinicians in the use of advanced neuroradiologic imaging techniques such as MR perfusion, MR spectroscopy, functional MRI and advanced CT protocols.
- Present pre-reviewed cases in a complete, concise and accurate fashion during readout.
- Produce clear and concise radiology reports.
- Participate in teaching of residents and medical students.

### **Professionalism**

- Demonstrate altruism (putting the interests of patients and others above own self-interest).
- Demonstrate compassion: Be understanding and respectful of the patients, patient families, and staff and physicians caring for patients.
- Be honest with patients and all members of the health care team.

- Interact with others without discriminating on the basis of religious, ethnic, sexual or educational differences and without employing sexual or other types of harassment.
- Demonstrate positive work habits, including punctuality and professional appearance.
- Demonstrate an understanding of broad principles of biomedical ethics.
- Demonstrate principles of confidentiality with all information transmitted during a patient encounter.
- Attend in-house and on-call duties as required by the rotations in compliance with regulations
- Formulate and get approvals for the research projects for thesis within the first 6 months of starting the training.

## **2. ACADEMIC PROGRAM COMMITTEE**

### **2.1 Duties of the Head of the Department:**

1. Overall supervision of the conduct of academic programs and evaluation process in the department.
2. Assess the quality and adequacy of content of academic program.
3. Evaluate the progress of each student through the APC.
4. He / She will be member of the appraisal committee and will assess the remedial measures taken to enhance performance of the resident/student.
5. Conduct of the external examination and supervision of conduct of internal examinations.

## **2.2 Program In-Charge (PIC)**

The Program In-Charge is accountable to the Head of the Department of IS&IR the Board of studies and the Academic council. The Program In-Charge will ensure that the formal teaching available in the program is organized, relevant, and continually updated. Assistance and resources will be provided to faculty involved in educational programs. The Program In-Charge acts as a liaison between the residents and faculty, frequently in the role of resident advocate. Residents' specific needs and requests are to be dealt with compassionately and rationally. With the assistance of faculty, the Program In-Charge is required to have an ongoing awareness of resident performance. Concerns must be taken to the resident and the faculty in a timely manner.

### **Duties of the Program In-Charge, assisted by the residency training committee include:**

1. Will be responsible for ensuring the implementation of academic programs as envisaged by the BOS.
2. Assign equal number of academic programs for each resident for each year and ensure it is conducted
3. Supervise the conduct of evaluation of academic programs by PC
4. Supervise the internal evaluation process
5. Organize external and internal examinations
6. Verify and validate entry of marks in the e-portfolio after it has been verified and validated by PC.
7. Report to BOS/academic council, deficiencies, suggestions and feed back on the upgraded curriculum and evaluation.

### **2.3 Programme Co-ordinator (PC):**

The Programme coordinator will function as a personal educational supervisor for the residents and will be accountable to the program In-Charge. The role of the Postgraduate training coordinator as a supervisor is to support the clinical and academic learning process throughout the training period.

#### **Specific duties of the programme co-ordinator include:**

1. Circulate monthly academic roster of department and send a copy to the academic division for its records
2. Maintain dossier for each student till the end of the course
3. Circulate and collect evaluation forms after each academic program
4. Maintain register of attendance in academic programs of both students and faculty.
5. Enter and validate entry of information and marks for each student for each program at the end of each month in the e-portfolio.
6. E-portfolio entry, if made by dept secretary, should be verified and validated
7. Monitor log book entries
8. Organize appraisal meetings
9. Collect student feedback
10. Organize internal examination
11. Report to PIC periodically about progress and problems with implementation and resolve them.  
Can seek guidance from academic council if needed

## **2.4 Research guide mentor:**

Each student should have a mentor in the department. A research mentor will be assigned for the thesis and research projects. The Research mentor is the primary liaison between residents and faculty for research and works to ensure that the research requirements of the department are met.

### **Specific duties**

1. The mentor could be the thesis guide for post doctoral courses or any other faculty member nominated by the APC.
2. Can guide the student in the selection of appropriate thesis topic, process of submission to TAC and IEC, both procedures being mandatory.
3. Ensure participation and presentation in a national conference-mandatory requirement
4. Guidance for publication of research paper
5. Review abstract submitted for conference and ensure that abstract is sent to e-portfolio
6. Participate in appraisal meeting conducted by departmental academic
7. Committee and assist in planning remedial actions for candidates' progress
8. Guide and counsel students in managing work and stress
9. Guidance students in planning their careers

### **3. EDUCATIONAL STRATEGIES**

#### **TRAINING SYSTEM**

Exclusively on whole time in service basis, on residency pattern.

#### **ELIGIBILITY**

##### ***Essential***

M D (Radiodiagnosis) degree of an Indian University recognized by the Medical Council of India or any other equivalent examination recognized for the purpose by the MCI.

##### ***Mode of Selection***

Once a year on All India basis, based entirely on merit (by a written test followed by departmental assessment and Board interview). For written test (MCQ. type) 50% of questions should be of level of MD (Radiodiagnosis) and the rest 50% will be from the subspecialty. Those acquiring more than 50% marks in the theory will be eligible for departmental assessment. Approximately three times of the number of post available should be called for departmental assessment strictly on the basis of merit. Two times the post available will be shortlisted for the final Board interview.

#### **3.1 CLINICAL TRAINING**

The clinical training program will be modular, wherein, the clinical modules will be clearly defined. It has been designed to provide the candidate a comprehensive clinical training in different aspects of Neuroradiology.

### The Clinical training modules and their duration (months)

|       | USG | CT | MRI | DSA | OP | Allied Specialty | Outside posting |
|-------|-----|----|-----|-----|----|------------------|-----------------|
| 3 Yrs | 3   | 6  | 6   | 14  | 4  | 2                | 1               |

*Allied specialty Postings: Neurology including ICU 1 month, Neurosurgery including ICU and Anesthesia 1 month. Outside posting in NIMHANS/AIIMS , preferable at NIMHANS because of facility of PET/MR & Trauma imaging in the neuroradiology department at NIMHANS*

### TRAINING METHODS

1. Clinical teaching in the daily case discussions, teaching programmes, out patients clinics and interventional labs.
2. Special teaching sessions like Neuroradiology rounds, Neuropathology rounds and Neurology-Neurosurgery- Neuro- oncology case discussions.
3. Seminars, journal clubs, mortality, morbidity conferences and faculty lectures.
4. Treatment planning sessions.
5. Assisting and performing Neuro-diagnostic and interventional procedures.
6. Paper presentations at conferences.
7. Preparation of manuscript for publication.
8. Training in an experimental / research activities and simulators.

### BASIC TOPICS

(Detailed syllabus and syllabus for part I and part II are given in annexure 3)

- Neuroanatomy
- Neurophysiology
- Neuropathology & microbiology
- Neuropharmacology and Biochemistry
- Physical principles of imaging
- Instrumentation and Biomedical Engineering
- Stereotactic Radiotherapy and procedures

- Epidemiological Studies and Biostatistics

### **CLINICAL TOPICS**

(Detailed syllabus and syllabus for part I and part II are given in annexure 3)

- Diagnostic Neuroradiology: Principles and practice of clinical and applied neuroradiology.
- Interventional Neuroradiology: Principles and practice of Interventional Neuroradiology
- Relevant Neurology, Neurosurgery, Neurocritical care, Neuro-ophthalmology, Otorhinolaryngology:- Principles theory and practice
- Experimental Neuroradiology
- Practice Management, Legal, and Socioeconomic issues in Neuroradiology.

### **RESEARCH**

The resident should review and understand all principles of the scientific methods.

The resident should master the area of scientific inquiry involved in his research.

This knowledge should be adequate to serve as the basis for future academic activity.

The resident should teach the basic principles of his research area to other residents and faculty. The resident should master the principles of scientific manuscript preparation during this rotation.

### **3.2 CURRICULUM**

A well-defined preset curriculum will be implemented during the 3-year DM program. The trainee residents are expected to actively participate in the academic activities conducted during their training period. The curriculum will be announced by program In-Charge of Neuroradiology division at the commencement of the training period.

**The curriculum will include the following:**

Structured teaching program: Attending and presenting lectures, seminars, symposia, journal clubs, clinical case discussions, panel discussions, etc

Maintenance of the record of experience - the log book

Thesis/at least one project

**3.2.1 Mandatory requirements to be met by all senior residents**

**I. Publication: ( credits 5)**

At least one scientific paper- original article from the thesis as first author should be submitted for publication before the end of the course (three months before course completion) and final evaluation. There will be uniform credit of 5 for satisfying this requirement.

**II. Conference attendance ( 5 credits)**

There should be one paper/poster presented at a national, regional or international conference. There will be equal credit of 5 for this.

The senior resident has to present certificate of participation to PC and submit abstract of presentation to the PC and also ensure entry in e-portfolio

**III. Statistics course for senior residents: (credits 5)**

Students have to get minimum of 80% attendance for the mandatory course (20 hours) in statistics. There will be an evaluation at the end of the course and marked for performance.

Marks will be entered in e-portfolio.

**IV. BMT wing posting for senior residents (3 credits)**

2 week course and evaluation. 80% attendance is mandatory and there will be end of course evaluation and marks given and entered in e-portfolio.

### **3.2.2 Structured teaching programme:**

The responsibility for planning and implementing the annual academic program of DM Neuroradiology will be shouldered by the program coordinator. A structured teaching program will be implemented for the trainee residents, which will principally include, although not restricted to lectures, seminars, symposia, clinical cases, journal clubs, panel discussions, etc. Every DM resident will be informed about the annual academic program at the beginning of the academic year and will be expected to present the allotted topics. A faculty will be assigned the task of moderating the presentation topic prepared by the trainee resident. Presentation articles for journal clubs are chosen by residents under the guidance of the faculty moderator. Anyone wishing to suggest particular papers for discussion, which is not included in the annual schedule, is encouraged to forward the articles to the program coordinator. The residents ensure that they remain punctual for attending the academic sessions. Attendance at academic sessions is mandatory for residents, although it is understood that residents on call duties may not be able to attend.

**The academic schedule of the department will be as follows:**

|   | Academic sessions  | Day           | Time                            |
|---|--|---------------|---------------------------------|
| 1 | Neuroradiology Seminar<br>Consultant Class                                 | Monday        | 8:00-9:00 am<br>3:00-4:00 pm    |
| 2 | Journal club   | Tuesday       | 8:00-9:00 am                    |
| 3 | Neurovascular meeting<br>Epilepsy meeting                                  | Wednesday     | 8:00-9:00 am<br>4:00-5:00 pm    |
| 4 | DAMIT – Technologists' Seminar<br>Stroke Meeting                           | Thursday      | 8:00-9:00 am<br>4:00-5:00 pm    |
| 6 | Follow up & Interesting cases<br>Neuroradiology- Pathology Case discussion | Friday        | 8.00-9.45 am                    |
| 7 | Neuroradiology Meet<br>Neuropathology                                      | Alt Saturday  | 8.00-10.00am<br>2:00-3:00 pm    |
| 8 | Neuroradiology Case Discussion with consultant                             | All week days | 9:00 –10: 00 am<br>3:00-4:00 pm |
| 9 | Clinical case / bedside discussion<br>Neurology Case discussion            | Weekly once   | One hour                        |

### **3.3 PORTFOLIO**

A portfolio can be defined as a purposeful collection of information that demonstrates development or evidences learning outcomes, skills or competencies.

#### **Benefits of portfolio to the trainee:**

Effective portfolios provide a structure to guide the resident through the learning process, enabling them to set and review personal goals, targets and objectives. Portfolio-based learning helps residents use structured reflection to identify specific learning needs.

Work-based assessments by the supervisors may demonstrate whether the trainee has attained practical skills appropriate to Neuroradiology specialty. This should be used alongside a record of all completed procedures (logbook) to ensure the breadth and quality of experience is represented. Portfolios can maintain record of procedures and allow learning points to be noted alongside. This can be powerful as the learning from successes and failures is reviewed by the trainee and supervisor.

#### **Benefits of portfolio for the program In-Charge and supervisors:**

The curriculum functions like competency framework and is often used to define the specific assessments, competencies and examinations that trainees must attain at differing levels of training. The integration of curriculum within Portfolio can be a valuable focus for discussion in educational supervision.

The portfolios provide potential to evaluate a doctor's ability to reflect on practice and learn from experience. Portfolios provide an infrastructure to record all educational and clinical supervision meetings, personal development plans, personal reflections and a plan of development, along with skills and a record of work-based assessments. This provides supervisors and program directors with a transparent longitudinal record ensuring that a trainee's progress can be reviewed as he/she rotates from post to post.

#### **3.3.1 The record of experience - the log book**

Trainees will be expected to maintain a Log book of the clinical activities and academic experiences.

The log book is part of the portfolio, which should be maintained in the form of a printed copy and an electronic version.

**The log book has the following functions:**

It provides trainees with a personal record of all procedural and other training experiences, which are requirements for satisfactory completion of the training program.

It will be used by the Educational mentor to monitor the trainee's experience to ensure that it is appropriate.

**Procedure of completing the logbook:**

The trainee residents should enter the data regarding their clinical and academic experiences in a format of weekly data entry chart. All residents are expected to complete the weekly data entry charts at the end of the same week. Instructions for completing the charts will be available with the format logbook.

The weekly data entry charts must be attested by the concerned consultants every week. All charts must be preserved and produced for verification to the Program In-Charge of DM Neuroradiology at the time of final preparation of logbook.

Resident doctors should create a logbook folder in their personal computer similar to the format logbook. It will be a good practice to update the data in the logbook folder at regular intervals. Completed log book should be submitted on or before of September 30eth.

**3.3.2 Submission of Thesis:**

Submission of at least one thesis project is compulsory for the trainee DM residents, who should design the project under guidance of the research mentor. It will be recommended for the trainees to submit the thesis proposals within 3 months after joining the program and necessary permissions and fundings should be sought within 6 months of joining the programme.

The project must be approved by the institute technical advisory committee (TAC) and the institute ethics committee (IEC).

Guidelines for preparation and submission for the TAC and IEC are available in the institute web site

Submission of thesis for publication should be done at 30months and will be evaluated by external examiners/experts.

### 3.3.3 Conducting research:

**Research categories:** The research projects may be of 2 categories: Clinical research:

Residents can gain research experience either by joining departmental clinical projects or collaborative studies with other departments. The project design may be prospective or retrospective. Conducting retrospective analysis of large case series may also be considered as clinical research.

All clinical research projects must be submitted to the Institute technical advisory committee and institute ethics committee for approval.

#### **Biomedical technology research:**

One of the objectives of Institute is to enable the indigenous growth of biomedical technology.

All trainee residents must complete a the introductory course in biomedical technology wing of the institute (**mandatory BMT wing posting for senior residents**).

Biomedical technology research may be conducted under the guidance of research mentor in collaboration with the scientist-engineers in the biomedical technology wing.

## 3.4 CONTINUING PROFESSIONAL DEVELOPMENT:

### 3.4.1 Performance evaluation by faculty members:

Residents in Neuroradiology participate in the provision of radiology services both inside and outside the diagnostic and interventional Neuroradiology suits. All resident activities must be supervised by the responsible attending consultant . The degree of this supervision must take into account the condition of each patient, the nature of the radiology service, and the experience and capabilities of the resident (increasing professional responsibility). At the discretion of the supervising consultant ,residents may provide a range of patient care/intervention with minimal supervision. In all cases, the supervising attending consultant must remain readily available to give advice or assist the resident with urgent or routine patient care. Whether supervision is direct or indirect, close communication between the resident and the responsible supervising faculty is essential for safe patient care. The faculty members, who are involved in supervising the training process, will provide their honest opinion on performance evaluation of the trainees and report it to the program In-

Charge.

Competency in following core areas will be assessed by the faculty members:

1. Patient care
2. Medical knowledge
3. Practice-based learning and improvement
4. Interpersonal and communication skills
5. Professionalism
6. Systems-based practice

The performance evaluation should be done by senior faculty members (Additional Professors and Professors) and mentor of the resident.

Program In-Charge should allot a number to each senior faculty member to document it on the chart. The number may be allotted in randomized fashion rather than in the order of seniority. Individual faculty member should return the assessment chart to the program In-Charge, without mentioning his/her name on it. It will help the program

In-Charge in identifying the faculty; simultaneously maintaining confidentiality on the matter.

The program In-Charge should summarize performance rating of individual faculty before the process of appraisal.

Format for the performance evaluation is provided in ANNEXURE.

#### **3.4.2 Mid-term Appraisal:**

Good Medical Practice is central theme to appraisal. The appraisal should include data on clinical performance, training and education, audit, concerns raised and serious clinical complaints, application of relevant clinical guidelines, relationships with patients and colleagues, teaching and research activities, and personal and organizational effectiveness.

#### **Appraisal process:**

The appraisal committee will consist of 3 members:

Head of the department, Mentor Programme In-Charge of neuroradiology and two Appraiser nominated by the Board of Studies, preferably a faculty from other department. Every DM candidate will be appraised in the mid-term of every academic year, preferably in the month of July. Process of appraisal is mentioned in ANNEXURE. The Appraisal committee will submit its report card to the Board of studies for further evaluation.

### **3.4.3 Personal development planning:**

Personal development planning (PDP) is a structured and supported process undertaken by individuals that enables them to reflect on their own learning, performance and achievement. It allows the individual to plan personal, educational and career development. It typically includes a statement of one's aspirations, strengths or competencies, education and training, and stages or steps to indicate how the plan is to be realized. A PDP is developed in agreement with the appraisal committee every mid-term. The personal development plan should include identifying and developing areas of special interest in the training process.

Following parameters have been identified for the purpose of crediting.

1. Invasive procedures performed
2. Emergency duties attended
3. Departmental activities attended
4. Clinical biomedical technology research conducted
5. Attending academic events

Resident doctors are expected maintain records pertaining to the departmental activities, which will award them credit points. Please refer ANNEXURE for credit point system.

### **Out-of-bounds before appearing for examinations:**

A period of one week before the final theory examination of Part II will be “out of bounds” to senior residents. Attendance has to be marked on these days as usual. The residents will be free of all duties during this period.

### ***Feedbacks from residents:***

Without feedback from residents the department cannot make improvements. The resident

doctors are strongly encouraged to present their overall impressions about the program every 6 months. Re-appraisal meetings will be conducted at 6 monthly intervals, to evaluate the progress.

### **3.6 EXAMINATIONS AND FINAL ASSESSMENT**

Each DM candidate has to pass 2 examinations before the DM degree is awarded.

Part I examination will be conducted at the end of first 18 months of training. Those unable to clear the Part I examination in first attempt may write the examination after 6 months. Their training process in the department continues during those 6 months.

Those who have passed part I examination may appear for Final (part II) examination at the end of the training program.

In addition to this, internal evaluation by the Academic division including theory papers with limited syllabus will be conducted at 6 monthly intervals.

#### **Distribution of marks in examinations**

Internal assesment - 200 marks

Part I theory – 200 marks (paper I and paper II), 50% required for pass

Part II theory – 200 marks (paper I and paper II), 50% required for pass

Part II practical examination – 400 marks, 50% required for pass

Case discussion – long case 100 marks, short case 100 marks (total 200 marks)

Spotters – 100 marks

Viva – 100 marks

Candidate has to score 50% for Part II theory and practicals separately to pass.

### **3.7 CERTIFICATION**

The final marks at the end of each year will be converted to absolute grades

Grade A = >80%, B=60 to 80%, C = 40 to 59%, D =<40%.

Total marks of internal and external examinations will given as transcript to student with final grades for both. The final transcript of the student will have only the grades of each activity, and not the individual marks for each session. The transcript will also specify the credit weightage for that particular activity/ posting.

**Annexure: 1**

**SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND TECHNOLOGY**

**TRIVANDRUM, KERALA**

**EVALUATION FORM FOR CLINICAL/CASE PRESENTATION**

Name of the student:

Name of the Faculty / Observer:

Date:

| <b>Sl. No.</b> | <b>Items of observation during Presentation</b> | <b>Poor<br/>0</b> | <b>Below average<br/>1</b> | <b>Average<br/>2</b> | <b>Good<br/>3</b> | <b>Very good<br/>4</b> |
|----------------|---|-------------------|----------------------------|----------------------|-------------------|------------------------|
| 1              | Completeness of history                         |                   |                            |                      |                   |                        |
| 2              | Accuracy of clinical and Imaging findings       |                   |                            |                      |                   |                        |
| 3              | Clarity of Presentation                         |                   |                            |                      |                   |                        |
| 4              | Assessment of problem and investigational plan  |                   |                            |                      |                   |                        |
| 5              | Diagnosis/Treatment plan                        |                   |                            |                      |                   |                        |
| 6              | Ability to defend diagnosis and plan            |                   |                            |                      |                   |                        |
| 7              | Knowledge of the current and past literature    |                   |                            |                      |                   |                        |
|                | <b>Grand Total</b>                              |                   |                            |                      |                   |                        |

### EVALUATION OF JOURNAL PRESENTATIONS

Name of the Student:

Name of the Faculty / Observer:

Date:

| Sl. No. | Items of observation during Presentation                                    | Poor<br>0 | Below average<br>1 | Average<br>2 | Good<br>3 | Very good<br>4 |
|---------|---|-----------|--------------------|--------------|-----------|----------------|
| 1       | Extent of understanding of scope & objectives of the paper of the candidate |           |                    |              |           |                |
| 2       | To critically evaluate methods, analysis and interpretations of study       |           |                    |              |           |                |
| 3       | Whether cross references have been consulted                                |           |                    |              |           |                |
| 4       | Whether other relevant publications consulted                               |           |                    |              |           |                |
| 5       | Ability to respond to questions on the paper / subject                      |           |                    |              |           |                |
| 6       | Ability to defend the paper   |           |                    |              |           |                |
| 7       | Clarity of Presentation   |           |                    |              |           |                |
| 8       | Audio – Visual aids used  |           |                    |              |           |                |
| 9       | Ability to propose new research ideas based on study discussed              |           |                    |              |           |                |
|         | <b>Total Score</b>  |           |                    |              |           |                |

### EVALUATION OF SEMINAR PRESENTATIONS

Name of the student:

Name of the Faculty / Observer:

Date:

| Sl. No. | Items of observation during Presentation    | Poor<br>0 | Below average<br>1 | Average<br>2 | Good<br>3 | Very good<br>4 |
|---------|---|-----------|--------------------|--------------|-----------|----------------|
| 1       | Whether all relevant publications consulted |           |                    |              |           |                |
| 2       | Understanding of the subject                |           |                    |              |           |                |
| 3       | Completeness of the preparation             |           |                    |              |           |                |
| 4       | Clarity of presentation                     |           |                    |              |           |                |
| 5       | Current concepts coverage                   |           |                    |              |           |                |
| 6       | Ability to answer the questions             |           |                    |              |           |                |
| 7       | Time scheduling                             |           |                    |              |           |                |
| 8       | Appropriate use of Audio – Visual aids      |           |                    |              |           |                |
| 9       | Overall performance                         |           |                    |              |           |                |
| 10      | Any other observation                       |           |                    |              |           |                |
|         | <b>Total Score</b>                          |           |                    |              |           |                |

### EVALUATION OF CLINICAL WORK IN WARD / OPD

Name of the student:

Name of the Faculty / Observer:

Date:

| Sl. No. | Items of observation during presentation  | Poor<br>0 | Below average<br>1 | Average<br>2 | Good<br>3 | Very good<br>4 |
|---------|---|-----------|--------------------|--------------|-----------|----------------|
| 1       | Regularity of attendance and punctuality  |           |                    |              |           |                |
| 2       | Presentations of cases during rounds  |           |                    |              |           |                |
| 3       | Maintenance of case records   |           |                    |              |           |                |
| 4       | Investigations workup   |           |                    |              |           |                |
| 5       | Interaction with colleagues and supporting staff                                |           |                    |              |           |                |
| 6       | Teaching and training junior colleagues   |           |                    |              |           |                |
| 7       | Bedside Manners   |           |                    |              |           |                |
| 8       | Rapport with patients and family  |           |                    |              |           |                |
| 9       | Counseling Patient's relatives for blood donation or postmortem and case follow |           |                    |              |           |                |
| 10      | Overall quality of clinical work  |           |                    |              |           |                |
|         | <b>Total Score</b>  |           |                    |              |           |                |







### MODEL OVERALL ASSESSMENT SHEET

Name of the college:

Academic Year:

| Sl. No. | Particulars                  | Name of the student and Mean score |    | C* | D* | E* | F* | G* | H* | I* | J* |
|---------|------------------------------|------------------------------------|----|----|----|----|----|----|----|----|----|
|         |                              | A*                                 | B* |    |    |    |    |    |    |    |    |
| 1       | Journal Review presentations |                                    |    |    |    |    |    |    |    |    |    |
| 2       | Seminars                     |                                    |    |    |    |    |    |    |    |    |    |
| 3       | Clinical work in wards       |                                    |    |    |    |    |    |    |    |    |    |
| 4       | Clinical Presentation        |                                    |    |    |    |    |    |    |    |    |    |
| 5       | Teaching skill practice      |                                    |    |    |    |    |    |    |    |    |    |
|         | <b>Total Score</b>           |                                    |    |    |    |    |    |    |    |    |    |

Note: Use separate sheet for each year.

**Signature of the HOD:**

**Signature of the Dean:**

The above overall assessment sheet used along with the log book should form the basis for certifying satisfactory completion of course of study, in addition to the attendance require

**Annexure:2****EVALUATION OF SENIOR RESIDENTS**

The internal evaluation of the senior residents will be based on grading. The grading will be based on the performance in each module with specified maximum marks against them.

The respective modules, with the maximum marks allotted against them, are given below.

**Internal assessment - total 200 marks**

|                  |  | <b>Marks</b> |            |
|------------------|--|--------------|------------|
| <b>Module 1</b>  | <b>Patient evaluation and management (30 marks)</b>                              |              |            |
|                  | 1. Ward posting  | 12           |            |
|                  | 2. Assessment of Outpatient training   | 10           |            |
|                  | 3. ICU and Emergency   | 8            |            |
|                  | <b>Total</b>   | <b>30</b>    | <b>30</b>  |
| <b>Module 2</b>  | <b>Clinical evaluation, Imaging performance and Interpretation (33 marks)</b>    |              |            |
|                  | 1. Evaluation of MRI: Reporting and Analysis                                     | 16           |            |
|                  | 2. Evaluation of CT: Reporting and Analysis                                      | 10           |            |
|                  | 3. Evaluation of USG/Doppler: Reporting and Analysis                             | 7            |            |
|                  | <b>Total</b>   | <b>33</b>    | <b>33</b>  |
| <b>Module 3</b>  | <b>Academic Presentation (30 marks)</b>  |              |            |
|                  | 1. Journal Review ( Duration 30 min each)  | 8            |            |
|                  | 2. Seminar 45 min  | 8            |            |
|                  | 3. Participation and presentations in Stroke and Neurovascular meet              | 2            |            |
|                  | 4. Participation and presentations in Radiology-Neuropathology presentations     | 2            |            |
|                  | 5. Participation and presentations in Neuroradiology meet                        | 5            |            |
|                  | 6. Clinical case discussion  | 5            |            |
|                  | <b>Total</b>   | <b>30</b>    | <b>30</b>  |
| <b>Module 4</b>  | <b>Invasive and interventional DSA procedures and decision making (45 marks)</b> | <b>45</b>    | <b>45</b>  |
| <b>Module 5</b>  | <b>Internal Examinations :Theory and Practicals (7 marks)</b>                    | <b>7</b>     | <b>7</b>   |
| <b>Module 6</b>  | <b>Outside training posting (5 marks)</b>  | <b>5</b>     | <b>5</b>   |
|                  | <b>Total</b>   |              | <b>150</b> |
| <b>Module 7</b>  | <b>Statistics</b>  | <b>5</b>     |            |
| <b>Module 8</b>  | <b>BMT wing postings</b>   | <b>3</b>     |            |
| <b>Module 9</b>  | <b>Paper submitted for publication</b>   | <b>4</b>     |            |
| <b>Module 10</b> | <b>Project/thesis</b>  | <b>20</b>    |            |

|           |                           |           |            |
|-----------|---------------------------|-----------|------------|
| Module 11 | Conference attended       | 4         |            |
| Module 12 | Award/ recognition/honors | 4         |            |
| Module 13 | Attendance                | 5         |            |
| Module 14 | Logbook                   | 5         |            |
|           | <b>Total</b>              | <b>50</b> | <b>50</b>  |
|           |                           |           |            |
|           | <b>Grand total</b>        |           | <b>200</b> |
|           |                           |           |            |

### **Module 1 : Patient evaluation and management (30 marks)**

#### **I. Ward posting (12 marks)**

The evaluation tools will be as follows,

1. Completion of admission and discharge summaries & at discharge patient education and prescription.
2. Evaluation of his understanding of the clinical problem of all inpatients under his charge and recognition using clinical laboratory parameters of patient's progress, deterioration or complications.
3. Identification of all clinical issues setting targets to be achieved at discharge.
4. Patient education and counseling especially with respect to post discharge life style, diet, exercise, behavior modification & drugs and drug interactions.
5. Clinical appreciation of bedside signs and symptoms
6. Interpretation of all laboratory and invasive and noninvasive test results
7. Discharge Summary quality and completeness
8. Bedside procedures including catheterization, wound and puncture site care

#### **2. Assessment of Outpatient training (10 marks).**

1. Clinical cases seen and discussed with Consultant.
2. Completeness of case history writing and the plan of management along with patient education and quality of prescription given to patient.
3. Interpretation of all routine investigation including Imaging & Laboratory reports.

4. Total evaluation / plan management strategy of patient on completed routine investigations.
5. Patients identified with new problem / worsening of existing clinical issues requiring change of management plan and management discussed with consultant and also presented to the Medical/Surgery Dept meetings charting out plan of management, with all relevant investigations.
6. Identification of critically ill patients and channeling their acute management.
7. Inter-departmental consultations

### **3. ICU and Emergency (8 marks)**

1. This includes evaluation of patient management in the ICU (newly admitted, transferred from wards, transferred after intervention procedure, etc) and charting out plan of management and carrying out the same.
2. All emergency room visits of patients outside office hours / their evaluation / charting out plan of management including ICU admissions and preparation for emergency intervention/surgery as indicated.

ICU training will include management of raised ICP, SAH/ICH, Vasospasm, stroke, Spinal shock, Seizure, Ventilatory care, Fluid-Electrolyte care and CPR protocol etc.

## **Module 2: Clinical evaluation, Imaging performance and Interpretation (33 marks)**

### **1. Evaluation of MRI: Reporting and Analysis (16 marks)**

Patient scheduling, evaluating, performing and reporting at least 500 MRIs in 3 years

1. To have a collection of at least 50 MRIs with all known abnormalities collected in a log book. (Including all advanced Neuroimaging studies and their clinical, imaging and histopathological follow up).

2. The evaluation will be based on the quality of the log book submitted.

## **2. Evaluation of CT: Reporting and Analysis (10 marks)**

Patient scheduling, evaluating, performing and reporting at least 500 CT studies in 3 years

1. To have a collection of at least 50 CTs with all known abnormalities collected in a log book. (Including all advanced Neuroimaging studies and their clinical, imaging and /histopathological follow up).
2. The evaluation will be based on the quality of the log book submitted.

## **3. Evaluation of USG/Doppler: Reporting and Analysis (7 marks)**

Analysis and reporting of at least 200 USG/ doppler cases with a collection of atleast 20 representative cases in the log book.

## **Module 3 : Academic Presentation (30 marks)**

### **1. Journal Review ( Duration 30 min each) [8 marks]**

Purpose of journal presentation is to instill qualities of enquiry and analysis of scientific medical articles and to evaluate its relevance and impact in understanding pathophysiology of disease or in clinical management. The resident can select recent articles of clinical relevance, or consult the faculty to help select scientific articles with original research content for presentation. The presentation should reflect the senior resident's understanding of the problem under discussion and the outcome and analysis of the results with regard to various aspects of disease state and the clinical relevance. Two articles with brief exposition of the highlights of the study and its clinical relevance and the take home message should be included. The senior resident should include a short report of all the articles presented in print in the log, highlighting the aim, methodology, patient recruitment criteria, results, discussion and implications for clinical practice.

**2. Seminar 45 min [8 marks]**

It is intended to encourage extensive literature review on the topic and present the highlights of the topic under review in a succinct manner with clear take home messages, but at the same time the extensive literature search elevates the presenter as an authority on the topic. The topic should be prepared as a review article with complete bibliography in a publishable format, along with the topic presentation. The presentation and the write up are equally weighted.

**3. Participation and presentations in Stroke and Neurovascular meet [2 marks]**

**4. Participation and presentations in Radiology-Neuropathology presentations [2 marks]**

**5. Participation and presentations in Neuroradiology meet [5 marks]**

**6. Clinical case discussion [5 marks]**

The purpose of this exercise is to identify daily clinical problems confronted during the routine hospitalization and management of patients, clinical problems significant enough to influence patient management (diagnosis/therapy). The literature review will be up to date, and will enable evidence based approach to patient management in different clinical scenarios. The assessment will be based on the following parameters; review of the literature to chart out evidence based management plan and to write up a short report on the clinical problems and the current state of the art management and the level of evidence for such management option. The oral presentation and the write up are equally weighted for purpose of evaluation.

**Module 4: Invasive and interventional DSA procedures and decision making ( 45 marks)**

Diagnostic Angiography atleast 50, Extracranial interventions 10, Intracranial and spinal Interventions 40

1. Pre-procedural work up and detailed knowledge of the case
2. Evaluation of available diagnostic images
3. Taking proper consent and investigations
4. DSA procedure Knowledge and execution ( as a First operator/ Assistant)

5. Post procedure care and orders

6. Follow up of patients

#### **Module 5. Internal Examinations :Theory and Practicals (7 marks)**

There will be internal practical and theory examinations, each having 100 marks during the 3-year course. These examination will be conducted at every 6 months.

#### **Module 6. Outside training posting (5 marks)**

Candidates will be send to other academic institutes having diagnostic interventional neuroradiologic training facilities for 1 month.

#### **Module 7: Statistics (5marks)**

Medical Statistics and research methodology training and examination

#### **Module 8: BMT wing posting (3 Marks)**

Biomedical Technology Wing posting and examination

#### **Module 9: Paper submitted for publication (4 marks)**

At least one scientific paper as first author should be submitted for publication before the end of the course and final evaluation.

#### **Module 10: Project/thesis (20 marks)**

1. Mid-term evaluation of projects and thesis are mandatory
2. Prospective / Retrospective Study
3. Ethical Committee clearance / Institute funding has to be obtained
4. Contribution of candidates experience in the study
5. Descriptive data collection / Quantitative data subjected to statistical analysis.
6. Midterm Review: At 18 months of DM course: Aims and objectives, review of literature, materials and methods ( exclusion / inclusion criteria), data collection and presentation (% of target of the project) and preliminary data analysis.
7. Review at 30 months: Presentation of the full project as thesis and also in publishable form, complete with statistical analysis, discussion, study limitations, conclusion, and bibliography.
8. Overall impact of the project in adding to our knowledgebase, and patient management. Between 30-34 months, the project should be sent for publication to peer reviewed journals.
9. Presentation of the project work as scientific presentation at national level and at state level -desirable. Additional publication ready manuscript should also be prepared.

**Module 11: Conference attended (4 marks)**

There should be one paper/poster presented at a national, state or international conference.

The senior resident has to present certificate of participation to PC and submit abstract of presentation to the PC and also ensure entry in e-portfolio

**Module 12: Award/ recognition/honors (4marks)**

Additional marks will be awarded for additional publications, projects, national and international conference presentations obtaining prizes, certificates of merits and awards etc.

**Module 13: Attendance (5 marks)****Module 14: Logbook (5 marks)**

# ANEEXURE: 3

## SYLLABUS

### Part - 1

#### Basic sciences

##### 1. Anatomy (gross and radiological anatomy)

- a. Embryology of brain, spinal cord, and their vascular system
- b. Basic correlative anatomy of the brain, spinal cord and peripheral nervous system
- c. Blood supply of the brain and spinal cord
- d. Embryology and anatomy of skull, face and head and neck.
- e. Anatomy of the musculo skeletal system relevant to the disease of nervous system
- f. Relevant embryology and anatomy of vascular system mainly related to aorta and brachio cephalic vessels.

##### 2. Physiology

- a. Basic and applied neurophysiology
- b. Basics of hemodynamics

##### 3. Pathology and microbiology

- a. General and specific neuropathology
- b. Applied use of electron microscopy and virology
- c. Applied bacteriology, parasitology and virology
- d. Neuro vascular pathology
- e. Pathology of congenital malformations, neonatal and perinatal CNS disorders
- f. Genetic and metabolic disorders of CNS

##### 3. Biochemistry and pharmacology

- a. Applied aspect of the brain chemistry in relation to neuroradiology
- b. Pharmacology of drug action in relation to neuro radiology
- c. Contrast media
- d. Antihypertensives, antiplatelets, anti coagulants

- e. Vasodilators and vaso constrictors
- f. Embolic agents
- g. Thrombolytic agents
- h. Anesthetics and analgesics with respect to neuro imaging and interventions.
- i. Anti epileptics

## **5. Physical principles of imaging**

- a. Image intensifier and flat panel detector
- b. Angiography and digital subtraction angiography
- c. Spiral and multislice CT, CT perfusion imaging, and recent advances
- d. Magnetic resonance imaging – hard wares, pulse sequences, MR spectroscopy, functional MRI, diffusion tensor imaging
- e. Ultrasound, doppler and colour doppler ultrasound
- f. Image processing in CT and MRI
- g. PACS and digital radiography
- h. Radionuclide scan, SPECT and PET

## **6. Instrumentation and bio medical engineering**

- a. Knowledge about the various imaging and interventional equipment in the department
- b. Patient monitoring equipments and various life support systems
- c. Catheters and other biomaterials used in interventional radiology
- d. Radiation protection principles and devices

## **7. Steriotactic radiotherapy and steriotactic procedures**

- a. Principle and practice of steriotactic radiotherapy using x-ray source and cobalt source
- b. Principle, theory and practice of steriotactic procedures on brain,spine and spinal cord

## **8. Epidemiological studies and biostatistics**

## Part - II

### Clinical Sciences

- a. Neuroradiology: Principles and practice of applied neuroradiology
- b. Interventional neuroradiology: principles and practice of interventional neuroradiology
- c. Neurology, neuro ophthalmology, neuro otorhino laryngology : principles, theory and practice
- d. Neuro surgery : principles and theory
- e. Experimental neuroradiology
- f. Recent advances in neuroradiology.

### Detailed syllabus for part I and part II

|                                  |
|----------------------------------|
| <b>DIAGNOSTIC NEURORADIOLOGY</b> |
|----------------------------------|

#### I. ADULT BRAIN

##### A. Normal anatomy

1. Skull, sutures
2. Major apertures
3. Hemispheres, cortex, gyri, sulci
4. Major fissures
5. Major cisterns
6. Basal ganglia, thalamus, hypothalamus, pituitary gland, pineal gland
7. Pons, cerebellum, cerebellopontine angle
8. Ventricles, choroid plexus
9. Vessels and major branches

##### B. Basic and Advanced Instrumentation

1. Computed tomography (CT)
  - a. Basic techniques
  - b. Spiral scanning
  - c. CT Angiography (CTA)
  - d. CT perfusion
  - e. Post processing
2. Magnetic resonance (MR)
  - a. Morphologic imaging Spin echo Gradient echo

Inversion recovery  
 Chemical shift imaging  
 Suppression techniques High-speed imaging  
 Diffusion/perfusion

- b. MR Angiography (MRA)
- c. Spectroscopy
- d. Perfusion : Contrast and Non contrast techniques
- e. Functional MRI
- f. Diffusion Tensor Imaging
- g. CSF Flow studies
- h. MR Fingerprinting , Quantitative MRI, Synthetic MRI
- h. Post processing of DTI, fMRI, connectivity, perfusion : Resident should independently do the post processing

### 3. Nuclear medicine

- a. Planar scintigraphy
- b. SPECT
- c. PET

### 4. Ultrasound

- a. General - techniques and physics
- b. Gray scale
- c. Duplex doppler
- d. Intra vascular Ultrasound

- 6. Basic principles of MEG, functional near infra red spectroscopy, TMS
- 7. Machine learning : Basic techniques and applications in neuroradiology
- 8. Virtual reality and Augmented reality in neuroradiology
- 9. 3D printing : in neuroradiology

## C. Congenital CNS lesions

- 1. Embryology of brain development
- 2. Normal variants
- 3. Disorders of organogenesis
- 4. Disorders of neuronal migration and sulcation
- 5. Disorders of diverticulation and cleavage
- 6. Posterior fossa cystic disorders
- 7. Disorders of histogenesis (phakomatoses)

## D. CNS Infections

- 1. Imaging strategies
- 2. Pyogenic infections
- 3. Encephalitis
- 4. Granulomatous infections

5. Infections in the immunocompromised host

### **E. Neoplasms and other masses**

1. Benign neoplasms of scalp or skull
2. Malignant neoplasms of scalp or skull
3. Intracranial tumor
  - a. Tumor classification by histology and Molecular subtyping (Regular updated WHO classification)
  - b. Tumor evaluation by location

### **F. Trauma**

1. Imaging strategies CT/MR/skull films
2. Mechanisms
3. Primary vs. secondary
4. Focal lesions
  - Cortical contusions
  - Diffuse axonal injury (DAI) -- shearing
  - Subarachnoid hemorrhage (SAH) Subdural hemorrhage (SDH)
  - Epidural hemorrhage (EDH)
  - Parenchymal hemorrhage with differentials
5. Ages of hemorrhage by CT/MR
6. Intraventricular hemorrhage
7. Diffuse cerebral swelling and edema
8. Herniation syndromes
9. Skull fractures, types, complications
10. Vascular injuries—dissection, pseudoaneurysm, penetrating injuries, lacerations, complications
11. Non-accidental trauma

### **G. White Matter Disease**

1. Multiple sclerosis
2. Acute disseminated encephalomyelitis (ADEM)
3. Small vessel ischemic disease, hypertension, vasc. dis. 02140
4. Radiation/chemotherapy changes
5. Trauma (axonal injuries)
6. White matter changes in the elderly
7. Osmotic myelinolysis (central pontine myelinolysis)
8. Dysmyelinating disorders

### **H. Cerebrovascular disease**

1. Ischemia and infarction
2. Spontaneous hemorrhage
3. Aneurysms
4. Cerebrovascular malformations
5. Angiography

**I. Metabolic disease**

1. Pituitary disorders
2. Thyroid disorders
3. Parathyroid disorders
4. Adrenal disorders
5. Intoxications, poisoning, metabolic encephalopathies
6. Diabetes mellitus
7. Pediatric disorders

**J. Generalized systemic disorders****K. Hydrocephalus****L. Cognitive imaging****II. Pediatric Neuroimaging (including genetics):**

1. Genetic basis of pediatric neuroimaging
2. Next Generation Sequencing- methods and advances
3. Pediatric neurometabolic disorders
4. Normal and abnormal myelination including hypo and dysmyelination and leukodystrophies
5. Quantitative myelin imaging
6. Genetics of developmental anomalies of the brain
7. Imaging of the premature baby
8. Fetal neuroimaging including fetal USG and MRI
9. Pediatric stroke, demyelination
10. Pediatric CNS tumors, WHO classification latest
11. Cranio- vertebral junction anomalies
12. Antenatal fetal interventions: importance of imaging
13. Image gently protocols for pediatric neuroimaging
14. Pediatric spinal anomalies
15. Systemic disorders of children affecting the CNS

**III. HEAD AND NECK****A. Deep spaces of the neck**

1. Buccal space (anatomy, contents)
2. Sublingual space
3. Submandibular space
4. Parotid space (anatomy, contents)
5. Parapharyngeal space (anatomy, contents)
6. Masticator space (anatomy, contents)
7. Retropharyngeal space (anatomy, contents)

8. Perivertebral space (anatomy, contents)
9. Posterior cervical space (anatomy, contents)
10. Pharyngeal mucosal space (anatomy, contents)
11. Visceral space (anatomy, contents)
  - a. Larynx and hypopharynx(anatomy)
  - b. Thyroid
12. Special issues
  - a. Perineural spread
  - b. Carotid encasement
  - c. Bone and cartilage involvement

## **B. Orbit**

1. Imaging techniques
2. Anatomy/embryology
3. Intra-ocular
4. Intraconal
  - a. Optic nerve
  - b. Extraneural
5. Conal (Extra-ocular muscles)
6. Extra-conal masses
7. Extraorbital
  - a. Paranasal sinus tumors extending into orbit
  - b. Paranasal sinus infections extending into orbit
8. Trauma

## **C. Paranasal sinuses**

1. Anatomy of paranasal sinuses
2. Congenital disease
3. Inflammation/infection
4. Benign sinus tumors
5. Malignant sinus tumors

## **D. Skull base**

1. Anterior skull base (anatomy)
  - a. Invasion of lesions from above b. Intrinsic bone lesions
  - c. Invasion of lesions from below
2. Central skull base (anatomy)
  - a. Invasion of lesions from above b. Intrinsic bone lesions
  - c. Invasion of lesions from below
3. Posterior skull base (anatomy)
  - a. Invasions of lesions from above b. Intrinsic bone lesions
  - c. Invasion of lesions from below

## **E. Temporal bone**

1. Imaging techniques (Multi-planar CT/MR)

2. Anatomy/embryology
3. Congenital anomalies
4. Inflammatory disease
5. Tumors
6. Trauma
7. Pulsatile tinnitus

#### **F. Cystic neck masses**

1. Second brachial cleft cyst
2. Thyroglossal duct cyst
3. Cystic hygroma
4. Laryngocele, internal, external
5. Abscess
6. Ranula
7. Dermoid/epidermoid

### **IV. SPINE**

#### **A. Anatomy and biomechanics**

1. Vertebral bodies
2. Facet joints and transverse processes
3. Lamina and spinous processes
4. Support ligaments
5. Specific characteristics of cervical, thoracic, and lumbar segments
6. Cranio-vertebral and lumbo-sacral junctions
7. Normal stability and motion

#### **B. Imaging modalities**

1. Role and relative merit of noninvasive imaging studies  
Plain radiography, CT, MR, nuclear medicine, PET imaging
2. Role of invasive procedures  
Myelography (including CT), angiography, biopsies, facet injections, nerve root blocks, discography, vertebroplasty

#### **C. Developmental spine disease**

1. Normal embryologic development of spine
2. Abnormalities of neurulation
3. Anomalies of caudal cell mass
4. Anomalies of development of the notochord
5. Congenital tumors
6. Syringohydromyelia

7. Craniovertebral anomalies
8. Dysplasia
9. Constitutional disorders

#### **D. Inflammatory and demyelinating disease**

1. Osteomyelitis
2. Discitis
3. Epidural and paravertebral abscess
4. Granulomatous infection
5. Meningitis (arachnoiditis)
6. Spinal cord lesions

#### **E. Neoplastic disease**

1. Neoplasms of bone
2. Intraspinal
  - Extradural
  - Intradural extramedullary
  - Intramedullary

#### **F. Trauma**

1. Mechanism of injury
2. Stable fractures and ligamentous injuries
3. Unstable injuries (involvement of the middle column and ligaments)
4. Traumatic disc herniation
5. Extrinsic cord compression
6. Cord contusion
7. Intra-spinal hemorrhage
8. Post-traumatic abnormalities
9. Postoperative findings

#### **G. Metabolic, endocrine, toxic**

1. Pituitary disorders
2. Thyroid disorders
3. Parathyroid disorder
4. Adrenal disorder
5. Osteoporosis
6. Osteomalacia, renal osteodystrophy
7. Intoxication, poisoning

#### **H. Systemic disorders**

1. Hematologic disorders
2. Histiocytosis
3. Sphingolipidosis
4. Amyloid

#### **I. Degenerative disease**

1. Arthritis
2. Degenerative joint disorders
3. Degenerative disk order

- a. Epidemiology and terminology
- b. Disc degeneration c. Disc herniation
- d. Spinal stenosis

#### **J. Vascular lesions**

- 1. Dural venous fistula
- 2. AVM
- 3. Cavernous angioma
- 4. Spinal cord ischemia and infarction
- 5. Vascular bone marrow lesions and ischemia

#### **K. Cystic lesions**

- 1. Extradural
- 2. Intradural extramedullary
- 3. Intramedullary

### **GENERAL VASCULAR CONSIDERATIONS FOR INTERVENTIONAL RADIOLOGY**

#### **PATIENT CARE**

Management of patients in the out patient clinic  
 Pre-procedural assessment  
 Intra procedural monitoring  
 Post-procedural management and followup  
 General pharmacologic considerations for critical care  
**Analgesia/anesthesia**

Managing general anesthesia and Conscious sedation

Antibiotic therapy

Anticoagulation and anti platelets

#### **VASCULAR DIAGNOSIS**

Embryology Normal anatomy Variant anatomy

Vascular anatomy: arterial and venous

Anatomy of collateral pathways

Epidemiology of vascular disease

## **VASCULAR PHYSIOLOGY, PATHOLOGY AND PATHOPHYSIOLOGY ARTERIAL AND VENOUS SYSTEM**

Normal histology/physiology/morphology of vascular systems  
 Hemodynamics: normal abnormal circulation  
 Pharmacologic agents for vascular system  
 Normal circulatory response and auto regulation  
 Disorders related to pharmacologic/extrinsic agent exposure  
 Atherosclerosis  
 Pathophysiology of arterial ischemia  
 Venous insufficiency and venous infarction  
 Aneurysms  
 Thromboembolic disorders  
 Dissection  
 Congenital vascular disorders  
 Cranial and spinal vascular malformations  
 Arterial effects of adjacent tissues/disorders  
 Arterial infection  
 Vascular alterations in neoplasia: vascular supply of neoplasms, primary vascular neoplasms, vascular invasion by neoplasms  
 Vascular alterations in inflammatory diseases  
 Systemic vascular disorders  
 Primary and secondary vasculitis  
 Altered vascular pathology in systemic disease states  
 Vascular trauma: injuries and vascular response to injury  
 Mechanical injury: acute and chronic  
 Thermal and radiation induced vascular injury  
 Alterations in coagulation status  
 Hypercoagulable states  
 Impaired coagulation  
 Post-operative or post-interventional disorders and management  
 Synthetic and endogenous grafts  
 Myointimal hyperplasia  
 Other/unclassified

### **LYMPHATIC SYSTEM Anatomy**

Lymphangiography  
 Performance Interpretation  
 Indications and contraindications  
 Risks

### **CONTRAST REACTIONS, IODINATED AGENTS**

Classification  
 Ionic vs. nonionic agents  
 Anaphylactoid reactions  
 Prevention  
 Treatment  
 Premedication  
 Dose dependent reactions  
 Acute and chronic renal effects

### **PROCEDURAL COMPLICATIONS**

Puncture site complications prevention and management  
 Catheterization-related complications (apart from puncture site)  
 Systemic/generalized complications

### **PHARMACOLOGY**

Vasodilators  
 Vasoconstrictors  
 Antihypertensives  
 Anti epileptics  
 Anticoagulants  
 Antiplatelets  
 Fibrinolytics  
 Common antibiotics  
 Management of diabetes

## **INTERVENTIONAL NEURORADIOLOGY**

### **BASIC ANATOMY**

#### **HEAD AND NECK**

Vascular Anatomy - Aortic arch, neck vessels and intracranial vessels  
 Collateral circulation and its variations in various diseases  
 Collateral circulation and anastomosis.

#### **SPINE AND SPINAL CORD AND VERTEBRAL COLUMN**

Spinal vascular anatomy - arterial and venous

Variations in spinal vascular system

Perivertebral vascular system

Detailed segmental classification of vessels, normal and pathologic angiographic anatomy

## **CLINICAL AND ENDOVASCULAR TREATMENT ASPECTS IN ADULTS**

### **1. OCCLUSIVE VASCULAR DISEASE**

Arterial Occlusive Disease  
 Cerebrovascular Physiology Arterial  
 Ischemic Stroke Atherosclerosis  
 Ischemic stroke treatment  
 Extracranial Carotid artery stenosis  
 Carotid angioplasty and stenting  
 Posterior circulation stroke and management  
 Intracranial angioplasty and stenting

Vasospasm - Medical and endovascular management

Venous Occlusive Disease  
 Etiology Incidence  
 Clinical presentation and natural history  
 Management and dural sinus thrombosis

### **2. TUMORS**

Meningiomas  
 Other bony and dural tumors  
 Nasopharyngeal tumors  
 Paragangliomas  
 Other head and neck tumors  
 Pretherapeutic evaluation and surgical strategy  
 Technical Aspects of embolization  
 Complications of Embolization.

### **3. TRAUMATIC ARTERIOVENOUS FISTULAE**

Carotid Cavernous Fistula  
 Etiology and Incidence  
 Clinical presentation signs and symptoms  
 Natural history and prognosis  
 Pretherapeutic evaluation  
 Therapeutic strategies  
 Follow-up protocol  
 Extracavernous Arteriovenous Fistulae  
 Vertebral Arteriovenous Fistulae  
 Common carotid Fistulae  
 External Carotid Fistulae  
 Malignant Fistulae

### **4. ANEURYSMAL VASCULOPATHIES**

Natural history of ruptured and un ruptured aneurysms  
 From Aneurysm to Aneurysmal Vasculopathies  
 Extradural Aneurysms  
 Intradural Aneurysms

- Intradural Artery dissections
- Intradural Giant Saccular and Non saccular Arterial aneurysms
- Infectious, immune, and inflammatory Intradural aneurysms
- Flow related arterial aneurysms and other aneurismal vasculopathies
- Therapeutic management
- Management of subarachnoid haemorrhage
- Subarachnoid haemorrhage of un known aetiology

## **5. DURAL ARTERIOVENOUS SHUNTS**

- Incidence and etiology
- Pathophysiology and the Osteo-dural Complex
- Classifications
- Clinical presentation
- Natural history and prognosis
- Angioarchitecture
- Pretherapeutic Evaluation
- Strategy and Technical Aspects of Embolisation
- Risks and complications
- Post embolisation care and Surgical options

## **6. CEREBRAL VASCULAR MALFORMATIONS**

- General Considerations
- Incidence
- Classification
- Clinical presentation
- Angioarchitecture
- Clinical and Angioarchitecture correlation
- Venous Variations
- Developmental Venous Anomalies
- Cavernomas
- Cerebral cavernous malformations Occult and cryptic malformations Sturge-Weber Syndrome

## **7. BRAIN AVMS**

- Indications
- Pretherapeutic Evaluation
- Therapeutic management strategy
- Embolization :
  - Staging of embolization
  - Partial targeted, partial palliative, curative
  - Pre surgical embolisation
  - Prior to radiosurgery embolisation

Size reduction  
 Emergency embolization  
 Surgical Excision  
 Radiosurgery

## **SPINE**

1. Spinal Angiography and Angiographic protocol
2. Spinal vascular malformations - Spinal dural AV fistula, Perimedullary AVF, Spinal cord Arteriovenous malformations

Incidence

Classification

Clinical presentation and aggravating factors

Spinal cord hemodynamics

Angioarchitecture of vascular malformations

Clinical and Angioarchitecture correlation

Natural History and prognosis

Pretherapeutic evaluation

Indications for treatment

Technical aspects of embolization and its results

Risks and complications of embolization

Post embolisation management

Surgery

Follow-up

3. Spinal column
  - Vertebral body hemangiomas
  - Benign Bony tumors Malignant Bony tumors
  - Embolization and Vertebroplasty
  - Osteoporosis and pain relief
  - Degenerative disc disease
4. Spinal cord tumors
  - Hemangioblastomas

## **CERVICO-FACIAL VASCULAR MALFORMATIONS**

Hemangiomas and Phace syndromes

Incidence

Classification

Natural history

Diagnostic and Pre-therapeutic evaluation

Management

Arteriovenous malformations of face and scalp

Incidence Classification

Natural history

Diagnostic and Pre-therapeutic evaluation

Indications and timing of embolization

- Objectives and Technical aspect of embolization
- Complications of Embolization
- Surgery
- Venous malformations
  - Incidence Classification
  - Natural history
  - Diagnostic and Pre-therapeutic evaluation
  - Sclerotherapy
  - Risks and complications of sclerotherapy
  - Post sclerotherapy Management
- Lymphatic and other malformations
  - Incidence
  - Classification
  - Natural history
  - Diagnostic and Pre-therapeutic evaluation
  - Sclerotherapy
  - Risks and complications of sclerotherapy
  - Post sclerotherapy Management

#### **ENDOVASCULAR TREATMENT SPECIFIC IN PEDIATRIC AGE GROUP**

Embryological and Anatomical basis of pediatric vascular diseases

#### **1. GENERAL FEATURES OF INTRACRANIAL ARTERIOVENOUS DISEASE**

- Congestive cardiac failure
- Hydrodynamic equilibrium and disorder
- Melting brain syndrome
- Clinical evaluation scores

#### **2. VEIN OF GALEN MALFORMATION**

- Incidence and etiology
- Natural History Prognosis
- Pretherapeutic evaluation
- Indications for treatment
- Concept of Window period
- Objectives and Methods of treatment
- Technical aspects of Embolization
- Post embolisation management Surgery
- Radiosurgery

#### **3. PIAL ARTERIOVENOUS MALFORMATION/BRAIN AVMS**

- Incidence and etiology
- Clinical presentation
- Natural History and Prognosis
- Pretherapeutic evaluation
- Indications for treatment
- Objectives and Methods of treatment
- Technical aspects of Embolization
- Post embolisation management
- Surgery
- Radiosurgery

#### **4. DURAL ARTERIOVENOUS SHUNTS**

- Classification
- Fetal changes in sinuses
- Dural Sinus malformation
- Infantile Dural Arteriovenous Shunt
- Adult type Dural arteriovenous shunt
- Other dural shunts

#### **5. INTRACRANIAL ANEURYSMS IN CHILDREN**

- Incidence and etiology
- Classification
- Locations
- Clinical presentation and natural history
- Outcomes
- Pretherapeutic evaluation
- Embolization
- Surgery

#### **6. ARTERIAL ISCHEMIC STROKES AND VENOUS STROKES**

- Epidemiology
- Moya-Moya disease
- Arteritis
- Spontaneous dissections
- Clinical presentation and natural history
- Imaging and pretherapeutic evaluation
- Treatment and management
- Outcomes and prognosis

#### **7. TRAUMA AND EPISTAXIS IN PEDIATRIC AGE GROUP**

- Tumor in nasopharynx
- Traumatic CCF
- Traumatic dural sinus thrombosis
- Traumatic dissection
- Traumatic pseudoaneurysms

#### **8. SPINAL VASCULAR LESIONS**

- Classification
- Spinal angiography and protocol for angiography

Angioarchitecture and clinical correlation Natural  
 History and prognosis Pretherapeutic evaluation  
 Indication for treatment  
 Objectives and goals for embolization. Risks and  
 complications of embolization Surgery

#### **9.CERVICO-FACIAL VASCULAR MALFORMATIONS**

Hemangiomas and Phace syndromes  
 Incidence Classification  
 Natural history  
 Diagnostic and Pre-therapeutic evaluation  
 Management  
 Arteriovenous malformations of face and scalp  
 Incidence Classification  
 Natural history  
 Diagnostic and Pre-therapeutic evaluation  
 Indications and timing of embolization Objectives and  
 Technical aspect of embolization Complications of  
 Embolization  
 Surgery  
 Venous malformations  
 Incidence Classification  
 Natural history  
 Diagnostic and Pre-therapeutic evaluation  
 Sclerotherapy  
 Risks and complications of sclerotherapy  
 Post sclerotherapy Management  
 Lymphatic and other malformations  
 Incidence Classification  
 Natural history  
 Diagnostic and Pre-therapeutic evaluation  
 Sclerotherapy  
 Risks and complications of sclerotherapy

#### **10.Chemo embolization for retinoblastoma**

Indication  
 Diagnostic and Pre-therapeutic evaluation  
 Procedure technique  
 Chemo therapeutic agents  
 Procedure related complications  
 Post procedure care

#### **Other Neuro interventional procedures**

Balloon occlusion test - indication and technical details

### Wada test - indication and technical details

Detailed understanding of all neuro intervention devices - Arterial sheath cum dilator, Diagnostic catheters related guide wires, Guide catheters, balloons, detachable coils, micro catheters, stents, flow diverters, micro wires and embolic agents.

#### **Recommended text books**

- a. Magnetic Resonance Imaging of the Brain and Spine Scott W. Atlas
- b. Diagnostic cerebral angiography Anne G. Osborn
- c. Interventional Neuroradiology: Strategies and Practical Techniques J. J. Connors, Joan C. Wojak
- d. Handbook of Cerebrovascular Disease and Neurointerventional Technique. Mark R. Harrigan, John P. Deveikis

#### **Recommended text books / Periodicals**

- a. American Journal of Neuroradiology
- b. Neuroradiology
- c. Journal of NeuroInterventional Surgery
- d. Journal of magnetic resonance imaging
- e. Neuro Imaging Clinics of North America
- f. Neurology
- g. Neurosurgery
- h. Journal of neurosurgery
- i. Neurology India