



**Amrita School of Medicine
Amrita Institute of Medical Sciences & Research
Centre
AIMS, Kochi**

DEPARTMENT OF RADIOTHERAPY

**Program
MD Radio Therapy**
(Revised with effect from 2016-2017 onwards)

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The students after successful completion of their training should have:

1. Theoretical and practical knowledge for competent, safe, compassionate & ethical multidisciplinary practice of oncology and should contribute to the future developments in oncology
2. A detailed knowledge of the epidemiology, etiology, pathology & natural history of human neoplasms.
3. Considerable knowledge, experience & skill in the clinical diagnosis of human neoplastic diseases.
4. Considerable familiarity & skill in the application off all imageology, nuclear medicine and ancillary diagnostic aids in the diagnosis and management of cancer.
5. A high level of technical expertise in all forms of radiation as a therapeutic tool used in radiotherapy and knowledge of the adverse effects of radiation including radiation related accompaniments.
6. Technical expertise and experience in the use of cytotoxic agents.
7. Familiarity with the role of surgery in the management of neoplastic diseases.
8. A sound capability to manage cancer patients as a whole, including
 - a) the complications associated with malignant diseases & its management.
 - b) Psychosocial problems
 - c) Prevention, rehabilitation & palliative care.
9. Capacity to interpret current advances in cancer management & research. (Clinical, laboratory or basic including radiobiology and molecular biology)
10. A basic knowledge of the different statistical methods used in the interpretation of data related to cancer (with special emphasis on planning & interpretation of clinical trials)
11. Attained a quality of specialty training comparable to the best of standards where after obtaining MD (Radiotherapy and Oncology) the individual is competent to
 - a) Provide best of care to cancer patients
 - b) Setup the specialty department of Radiotherapy and Oncology in different parts of India.
 - c) Interact with the government machinery & other agencies as a nodal person for developments in Oncology.

Program Outcomes

PO1: Theoretical and practical knowledge for competent, safe, compassionate & ethical multidisciplinary practice of oncology and should contribute to the future developments in oncology

PO2: A detailed knowledge of the epidemiology, etiology, pathology & natural history of human neoplasms.

PO3: Considerable knowledge, experience & skill in the clinical diagnosis of human neoplastic diseases.

PO4: Considerable familiarity & skill in the application off all imageology, nuclear medicine and ancillary diagnostic aids in the diagnosis and management of cancer.

Program Specific Outcomes

PSO1 A high level of technical expertise in all forms of radiation as a therapeutic tool used in radiotherapy and knowledge of the adverse effects of radiation including radiation related accompaniments.

PSO2 Technical expertise and experience in the use of cytotoxic agents.

PSO3 Familiarity with the role of surgery in the management of neoplastic diseases.

PSO4 A sound capability to manage cancer patients as a whole, including

PSO5 Skill in the management of the complications associated with malignant diseases & its management, including psychological problems.

PSO6: Competence in cancer prevention, rehabilitation & palliative care.

PSO7: A basic knowledge of the different statistical methods used in the interpretation of data related to cancer (with special emphasis on planning & interpretation of clinical trials)

PSO8: Competence to set up the speciality department of Radiotherapy and Oncology.

STUDENT ELIGIBILITY AND SELECTION METHOD.

Student Eligibility

For students not enrolled in MD (Radiotherapy and Oncology) course in any Medical College/Institute recognized by the Medical Council of India.

1. Passed the MBBS exam and has completed the compulsory internship.
2. Qualified in the entrance examination

DURATION OF THE COURSE:

1. The duration of the course shall be three (3) academic years in total.

CLINICAL POSTINGS:

Rotations Postings

1st Year

Clinical Oncology (In-patient ward and special clinics) six(6) months.

Radiation Physics –Two (2) months

Pathology/Radiobiology – One (1) month

Imaging – One (1) month

Cancer Epidemiology and Statistics – One (1) month

Cancer Research and Laboratory methods –Fifteen (15) days

2nd Year

Surgical Oncology and Critical Care (In –patient ward and special clinics)-One (1) month each i.e; Two (2) months in total

Palliative Care – Two (2) months

Medical Oncology including cancer chemotherapy (In-patient ward and special clinics)-Six months.

3rd Year

Radiation Oncology (Inpatient ward and special clinics)

Thesis /Dissertation

The thesis/dissertation will be done under the direct guidelines of the candidates guide and the same has to be submitted at least six (6) months before the final examination.

Final Examination

1. *The final examination of MD (Radiotherapy and Oncology) shall be held twice in a year at a center*
2. *Format of examination shall be as follows;*

a) Theory

- Essay type questions – Two (2) in number; 25 marks each
- Short answer type questions – Five (5) in number; 10 marks each
- There shall be no MCQs
- Content – as per syllabus.

b) Practical

- One (1) long case – 40 marks
- Three (3) short cases – 20 marks each
- Viva Voce
 - Instruments-20 marks
 - RT treatment planning (on a contour)- 20 marks
 - Imaging – 20 marks
 - Pathology Specimens – 20 marks
 - Grand Viva-20 marks

TOTAL- 200marks

- Number of Papers- Four (4)
- Title of the Paper
 - Paper 1 – Basic Science including Medical Physics, Radiobiology and Tumor Pathology, Cancer Epidemiology and Biostatistics
 - Paper 2- Principles and Practice of radiotherapy and Oncology

- Paper 3- Cancer Chemotherapy
- Paper 4- Recent advances

Duration of Examination – Three (3) hours each

Total marks – One hundred (100) in each paper i.e; Four hundred (400) for theory examination

Practical Examination

The entire practical examination will be conducted in one day for each candidate.
Maximum number of candidates examined per day – not to exceed Eight (8)

Number of examiners – Four(4) (including one convener). Convener will be from the host institute.

Components and Weightage

Practical

One (1) long case – 40 marks

Three (3) short cases – 20 marks each

Total –100 marks

Viva Voce

Instruments – 20 marks

RT treatment planning (on a contour)- 20 marks

Imaging – 20 marks

Pathology Specimens – 20 marks

Grand Viva - 20 marks

Total – 100 marks

Grand Total for Practical examination –200 marks

Practical and Clinical Training

Details of the training facilities.

I. Essential

- 1) Teletherapy unit (Telecobalt/ Linear Accelerator) – one
- 2) Brachytherapy system (Intracavitary and Interstitial)- one each
- 3) Treatment Planning system (TPS) – one
- 4) Mould room equipments – on set
- 5) Simulator / Diagnostic X-ray machine- one

II. Desirable **

- 1) Dual energy linear accelerator with electron facility –one
- 2) 2nd teletherapy machine (preferably linear accelerator)- one
- 3) Simulator- one
- 4) 3-D TPS & Virtual simulation –one
- 5) Remote after loading brachytherapy system –one
- 6) IMRT
- 7) Conformal therapy
- 8) Stereotactic radiotherapy
- 9) CT Simulator
- 10) Simulator- CT
- 11) Stereotactic Brachytherapy
- 12) Ultrasound guided brachytherapy
- 13) Radiobiology laboratory

Methods of Training and Teaching

1. Experience to be obtained by candidate prior to appearing for the final examination

1. Number of years of training –three (3) years
2. Teletherapy
2. Number of plannings – 30 per year
3. Brachytherapy
4. Procedure of ICRT, ILRT, Interstitial
5. Number of ICRT, ILRT, Interstitial – 30 per year
6. Manual planning with isodose chart- 50- per year
7. Training in QA of machines
8. Training in handling accessories
9. Training in radiation safety
10. Training in chemotherapy for solid tumors and lymphoreticular malignancies

II. Seminars and journal clubs

1. Seminars- Ten (10) per year (minimum)
1. Journal clubs –Ten (10) per year (minimum)

These are to be entered in the log book and signed by the candidate, consultant in charge and the Head of the Department.

Syllabus for MD (radiotherapy)

Structure

1. Basic Sciences
 - a) anatomy
 - b) Pathology

- General Pathology
- Systemic Pathology
- c) Radiotherapeutic physics
- d) Clinical Radiology
- e) Statistical basis for planning & interpretation of clinical trials.

2. Clinical Radiotherapy

3. Clinical Cancer Chemotherapy

3. Other disciplines allied to Radiotherapy and Oncology

4. Preventive and community oncology and Palliative care

5. Research, Training & Administration

1. Basic Sciences

1.1 Anatomy

1.1.1 Knowledge of surface anatomy pertaining to Oncology

1.1.2 Detailed knowledge of the all organs

1.1.3 Detailed knowledge of the lymphatic system of all organs-regions

1.1.4 Practical familiarity with the radiographic appearance of important regions (living anatomy)

1.1.5 Cross sectional anatomy

1.2 Pathology

1.2.1 General Pathology

1.2.2 Definitions of & distinction between different types of growth disorders (i.e; distinction between hyperplasia, hypertrophy, regeneration, malformation & neoplasia)

1.2.3 Malignant transformation-

Initiation & promotion stages of carcinogenesis.

Mode of origin- monoclonal, polyclonal, unifocal, multifocal

Structural & functional changes in the cellular components

Etiology, mechanisms of carcinogenesis, known types of carcinogens & their effects upon the cell. The relative importance of different factors in the causation of human cancer.

1.2.4 Rate of growth, methods of measurement

Factors affecting growth rate

Mechanisms of spread

Local effects of tumors

Local & systemic reactions to tumors

Effects of therapy on tumors & normal tissues

- 1.2.5 Criteria for tumor diagnosis-macroscopic, histological & cytological uses & value of biopsy material
- 1.2.6 Classification of tumors – histogenic, histological, behavioral & immunological
- 1.2.7 Nomenclature – solid tumors, lymphoproliferative disorders.
- 1.2.8 Structure & organization of tumors- vascular supply, stroma etc.
- 1.2.9 Systems of grading
- 1.2.10 Endocrine aspects of malignancy:- Production of hormones by tumors, effect of hormones on tumors, paracrine effects of tumors
- 1.2.11 Paraneoplastic syndromes
- 1.2.12 Etiology of cancer

Genetic Predisposition, congenital syndromes

Chromosomal abnormalities, hereditary tumors

Protooncogenes, oncogenes, tumor suppressor genes, viruses & malignancy

Multifactorial causation

Nutritional aspects in cancer causation and prevention.

Environmental causes of cancer

Biological – protozoal, bacterial, viral

Chemical – classes of carcinogenic chemicals, smoking

Physical – trauma, irradiation (UV rays, other electromagnetic radiation including X-rays and gamma rays and particulate radiations)

Common occupational cancers

Experimental tumors in animals relationship to human mutagenicity.

1.2.1.12 Tumor Immunology

Organization & development of the immune system and the role response in disease

Cellular basis of immunity & measurement of immune function. Graft versus host reaction.

Tumor immunity, tolerance, enhancement

Immune surveillance hypothesis

Immunological markers in diagnosis & monitoring

The I ILA systems.

1.2.1.13 Molecular biology for diagnostic and therapeutic purposes.

1.3 Radiation Oncology Physics

The aim of this subject is to provide the future Clinical Oncologist with the knowledge of physics required in clinical practice.

An understanding of the principles of planning & carrying out treatment is a necessary prerequisite & will be enhanced by the study of this subject.

A familiarity with the physics of electricity, atomic structure & electromagnetic radiation will be required.

With respect to their implications for accurate dose delivery in clinical radiation therapy, applicability, limitations, advantages & disadvantages of the various devices & techniques should receive particular attention.

Candidates should be encouraged to observe & gain practical experience with the equipment & techniques used in radiotherapy in clinical oncology departments.

1.3.1 Structure of Matter: Constituents of atoms, Atomic and mass numbers, Atomic and mass energy units, Electron shells, Atomic energy levels, Nuclear forces, Nuclear energy levels, Electromagnetic radiation, Electromagnetic spectrum, Energy quantisation, Relationship between Wavelength, Frequency, Energy

1.3.2 Nuclear Transformations : Natural and artificial radioactivity, Decay constant, Activity, Physical, Biological and Effective half-lives, Mean life, Decay processes, Radioactive series, Radioactive equilibrium

1.3.3 Production of X-rays : The X-ray tube, Physics of X-ray production, Continuous spectrum, Characteristic spectrum, Efficiency of X-ray production, Distribution of X-rays in space, Specifications of beam quality, Measurement of beam quality, Filters and filtration

1.3.4 Interaction of radiation with matter : Attenuation, Scattering, Absorption, Transmission, Attenuation coefficient, Half Value Layer (HVL), Energy transfer, Absorption and their coefficients. Photoelectric effect, Compton Effect, Pair-production
Relative importance of different attenuation processes at various photon energies

Electron interactions with matter: Energy loss mechanisms – Collisional losses, Radioactive losses, Ionization, Excitation, Heat production, Delta rays, Polarization effects, Scattering, Stopping power, Absorbed dose, secondary electrons.

Interactions of charged particles: Ionization vs. . Energy, Stopping Power, Linear Energy Transfer (LET), Bragg curve, Definition of particle range.

1.3.5 Measurement of radiation : Radiation Detectors : Gas, Solid – state, Scintillation, Thermo luminescence, Visual Imaging (Film, Fluorescent screens), and their examples.

Exposure, Dose, Kerma: Definitions, Units (Old, New), Inter-relationships between units, Variation with energy and material . Measurements of exposure (Free air chamber, Thimble chamber), Calibration of therapy beams: Concepts, Phantoms, Protocols (TG 21, IAEA TRS-277, TG 51) Dose determinants in practice (brief outline only, details not required)

1.3.6 Radiotherapy Equipment : Grenz ray, Contact, Superficial, Orthovoltage or Deep therapy, Supervoltage, Megavoltage therapy. Therapy and diagnostic X-ray units – comparison. Filters, factors affecting output,

Co-60 units : Comprehensive description of the unit, Safety mechanisms, Source capsule Linear accelerators, Source capsule Linear accelerators : History, Development, Detailed description of modern, dual mode linear accelerator, Linac head and its constituents , Safety mechanisms, Computer controlled linacs, Record and Verify systems.

Relative merits and demerits of Co-60 and linac units.

Simulators: Need for them , Detailed description of a typical unit, simulator CT.

1.3.7 Basic ratios, Factors, Dose distributions, Beam modifications and shaping in Teletherapy beams.

Characteristics of photon beams: Quality of beams, Difference between MV and MeV, Primary and scattered radiation.

Percentage depth dose , Tissue-Air Ratio, Scatter Air Ratio, Tissue-Phantom Ratio, Tissue Maximum Ratio, Scatter Maximum Ratio, Batch Scatter Factor, Peak Scatter Factor, Off-Axis Ratio, Variation of these parameters with depth, field size , source-skin distance, beam quality or energy, beam flattening filter , target material. Central axis depth dose profiles for various energies.

Equivalent square concept, Surface dose (entrance and exit) , Skin sparing effect, Output factors.

Practical applications : Co-60 calculations (SSD, and SAD technique), Accelerator calculations (SSD, and SAD technique)

Beam profiles Isodose curves, Charts, Flatness, Symmetry, Penumbra (Geometric, Transmission, and Physical) , Field size definition

Body inhomogeneities : Effects of patient contour, Bone, Lung cavities, Prosthesis on dose distribution. Dose within bone / lung cavities, Interface effects, Electronic disequilibrium

Wedge filters and their use, Wedge angle, Wedge Factors, Wedge systems (External, In built Universal, Dynamic / Virtual), Wedge Isodose curves

Other beams modifying and shaping devices : Methods of compensation for patient contour variation and / or tissue inhomogeneity – Bolus , Buildup material, Compensators, Merits and Demerits. Shielding of dose limiting tissue : Non-divergent and divergent beam block, Independent jaws, Multifocal collimators, Merits and Demerits.

1.3.8 Principles of Treatment Planning - I

Treatment planning for photon beams : ICRU 50 and NCAP terminologies . Determination of body contour and localization : Plain film, Fluoroscopy, CT, MRI , Ultrasonography, Simulator based.

Methods of correction for beam's oblique incidence, and body inhomogeneities

SSD technique and isocentric (SAD) technique : Descriptions and advantages of SAD technique

Combination of fields : Methods of field addition , Parallel opposed fields, Patient thickness vs. Dose uniformity for different energies in a parallel opposed setup, Multiple fields (3 fields, 4 field box and other techniques). Examples of above arrangements of fields is SSD and SAD techniques, Integral Dose.

Wedge field technique, Rotation Therapy (Arc, and Skip), Tangential fields. Beam balancing by weighting. Total and hemi-body irradiation. Field junctions.

1.3.9 Principles of treatment Planning - II

Limitations of manual planning. Description of a treatment planning system (TPS): 2D and 3D TPS. Beam data input , Patient data input (simple contour, CT, MR data, Advantages of transfer through media). Input devices (Digitizer, floppies, DAT devices, Magneto-optical disks, direct link with CT, MR). Beam selection and placement, Beam selection and placement, Beam's Eye View (BEV), Dose calculation and display (Point dose, Isodose curves, Isodose surfaces, Color wash). Plan optimization , Plan evaluation tools: Dose volume Histograms (Cumulative and Differential), Hard copy output, Storage and retrieval of plans.

Alignment and Immobilization : External and internal reference marks, Importance of Immobilization methods (Plaster of Paris casts, Perspex casts, bite block, shells, head

rests, neck roll, Alpha-Cradles. Thermoplastic materials, polyurethane foams), Methods of beam marks, and front / back pointers).

Treatment execution : Light field, Cross hair, ODIs, Scales in treatment machines.

Treatment verification : Port films, Electronic portal imaging devices, Invivo patient dosimetry (TLD, diode detectors, MOSFET, Film, etc) Changes in patient position, target volume , and critical volume during course of treatment.

1.3.10 Electron Beam Therapy

Production of electron beams : Production using accelerators, Characteristics of electrons. Surface dose, percentage depth dose, beam profiles, Isodose curves and charts, Flatness and Symmetry. Beam collimation, variation of percentage depth dose and output with field size, and SSD, photon contamination. Energy spectrum , Energy specifications, variation of mean energy with depth. Suitability of measuring instruments for electron beam dosimetry

Treatment planning : Energy and field size choice, air gaps, and obliquity, Tissue inhomogeneity – lung, bone, air filled cavities. Field junctions (with either electron or photon beam). External and internal shielding. Arc therapy, Use of bolus in electron beam.

Total Skin Electron Irradiation, Intraoperative Radiation therapy.

1.3.11 Physical Principles of Brachytherapy :

Properties of an ideal brachytherapy source, Sources used in brachytherapy : Ra-226, Cs-137, Ir-192, Au-198, Co-60, I-125, Sr-90, Yt-90, Ru-106, Ta-182 and other new radionuclides, their complete physical properties, Radium hazards. Source construction including filtration, comparative advantages of these radionuclides.

Histological background. Radiation and Dose units : Activity used, Exposure, Absorbed dose, mg-hr, curie, milli-curie, milligram Radium equivalent , roentgen, rad, γ gray. Source strength specification, Brachytherapy Dose calibrator.

Technique : Preloaded, After loading (manual and remote), Merits and Demerits. Surface, Interstitial , Intracavitary, Intraluminal, Intravascular brachytherapy , Low, Medium, High and Pulsed dose rates. Remote after loading machines, Detailed description of any one unit.

Dosage Systems: Manchester System (outline only), Paris System (working knowledge)

Treatment Planning: Patient selection, Volume specification, Geometry of implant, Number, Strength and Distribution of radioactive sources, Source localization, Dose calculation, Dose rate specification, Record keeping ICRU 38.

Radiation Safety: Planning of brachytherapy facility, Rooms and equipment, Storage and Movement control, Source inventory, Disposal, Regulatory requirements

Beta-ray brachytherapy including methods of use, inspection, storage and transport of sources, dose distribution

Unsealed radionuclides: Concepts of uptake, distribution and elimination, Activities used in clinical practice, Estimation of dose to target tissues, and critical organs, Procedures for administering radionuclides to patients.

1.3.12 Quality Assurance in radiotherapy.

(OART)

Overview of ESTRO QART: Need for quality system in Radiotherapy, Quality system: Definition and practical advantages, Construction, Development and implementation of a Quality system

Quality Assurance of simulator, Tips, Co-60, Linear Accelerator Acceptance testing of Simulator, TPS, Co-60, Linear Accelerator

1.3.13 Radiation Protection and Regulatory Aspects;

Statutory Framework – Principles underlying International Commission on Radiation Protection (ICRP) recommendations, ICRP and National radiation protection i.e; Atomic Energy Regulatory Board (AERB) standards. Effective dose limits (ICRP and AERB)

Protection mechanisms: Time, Distance and shielding. Concept of “As low as Reasonably Achievable” (ALARA)

Personnel and Area Monitoring; Need for personnel monitoring, Principles of film badge, TLD badge used for personnel monitoring. Pocket dosimeter. Need for area monitoring, Gamma Zone monitors, Survey meters

Regulatory aspects: Procedural steps for installation and commissioning of a new radiotherapy facility (Teletherapy and Brachytherapy). Approval of Standing Committee on Radiotherapy Development Programme. Type approval of unit. Site plan, Layout of installation / Associated facility: Primary, Secondary barriers, leakage and scattered radiation. Regulatory requirement in procurement of teletherapy / brachytherapy source(s). Construction of building, Qualified staff, Procurement of instruments, and accessories, installation of unit and performance tests. Calibration of unit, RP & AD approval for clinical commissioning of the unit.

Other regulatory requirements:

Regulatory consent, NOCs, Periodical reports to AERB and Radiological Physics and Advisory Division (RP & AD) , Bhaba Atomic Research Centre (BARC)

1.3.14 Advancements in Radiation Oncology:

Virtual Simulation: Principle, CT Simulation, TPS based virtual simulation, Differences, Merits and Demerits, Practical considerations

Conformal radiotherapy(CRT):

Principles, Advantages over conventional methods, Essential requirements for conformal radiotherapy.

Various methods of CRT:

1. With customized field shaping using conventional coplanar beams.
2. Multiple non-coplanar MLC beams conforming to target shape.
3. Stereotactic radiotherapy
4. Principle of inverse planning and Intensity Modulated Radiation Therapy (IMRT)
 - Using 3D compensator
 - Static IMRT (Step and Shoot technique)
 - Dynamic IMRT (sliding window technique)
 - Dynamic arc IMRT
 - Micro –MLC
 - Tomotherapy methods
5. Time gated (4D) radiotherapy

Merits and demerits of IMRT

Stereotactic irradiation methods: Physics Principles, Techniques, Description of units (Gamma Knife and Linac based). Merits and demerits, Stereotactic Radiosurgery (SRS) and Stereotactic Radiotherapy (SRT), whole body stereotactic frame.

Networking in radiotherapy: Networking of planning and treatment units in radiotherapy department including Picture Archival Communication System (PACS), Advantages, Patient Data Management

1.4 Radiobiology

1.4.1 Introduction to Radiation Biology

1.4.2 Radiation interaction with matter

Types of radiation, excitation and ionization. Radiation chemistry: direct and indirect effects, free radicals, oxygen effect and free radical scavengers, LET and RBE theory, dual action theory, intracellular repair, general knowledge of repair models.

1.4.3 Introduction to factors influencing radiation response.

Physical factors: dose, dose quality, dose rate, temperature
Chemical factors: Oxygen, radiosensitizers, radioprotectors

Biological factors: type of organism, cell type and stage, cell density and configuration, age, sex.

Host factors: Partial or whole body exposure.

1.4.4 Relevance of radiation biology to radiotherapy

1.4.5 Interaction of ionizing radiation on mammalian cells.

The cell: structure and function; relative radiosensitivity of nucleus and cytoplasm, mitosis, cell cycle, principles of DNA, RNA and protein synthesis, radiation effects on DNA, strand breakage and repair, common molecular biology techniques.

Cell injury by radiation: damage to cell organelle like chromatids, chromosomes; interphase death, apoptosis, mitotic death, micronucleus induction, SLD, PLD, Oxygen effect: mechanism, hypoxia, OER, reoxygenation in tumors, significance in radiotherapy. Dose rate. Brachytherapy sources including ²⁵²f. Radiobiology of low, high dose rate & pulsed brachytherapy, hyperfractionation, significance in radiotherapy.

Effects of low LET and high LET radiation on cell. Cell survival curves. Effect of sensitizing and protective agent. Dose modifying factors and their determination. Variation of response with growth and the progression of cell through the phases of cell cycle.

Physical factors influencing cell survival; relative biological effectiveness (RBE); its definition and determination, dependence upon linear energy transfer, dose, dose rate and fractionation. Hyperthermic and photodynamic injury.

Biological hazards of irradiation. Hyperthermic and photodynamic injury.

Biological hazards of irradiation; dose protection and LET, effects on the embryo and the fetus, life shortening, leukemogenesis and carcinogenesis, genetic and somatic hazards for exposed individuals and population. Biological basis of radiological protection.

1.4.6 Organ radiosensitivity and radioresponsiveness, concept of therapeutic index.

1.4.7 Acute effects on Radiation

Concept of mean lethal dose

Radiation Syndromes: BM, GI, CNS, Cutaneous

Suppression of immune System: mechanism, Consequences

Total Body irradiation

Biological dosimetry: Blood counts, BM mitotic index. Chromosome aberrations in peripheral blood lymphocytes

Radiation accidents: typical examples

1.4.2 Radiation effects on major organs/tissues

Acute & late effects on all normal organs & tissues including connective tissue, bone marrow, bones, gonads, eye, skin, lung, heart, central nervous system tissues, peripheral nerves, esophagus, intestine, kidney, liver & thyroid with special reference to treatment – induced sequelae after doses employed in radiotherapy

Normal tissue tolerances

1.4.2.1 Late effects of radiation (somatic)

Sterility, cataracts and cancer

Carcinogenesis: mechanisms in vitro and in vivo, oncogenes and antioncogenes
Radiation induced cancer of occupational, medical or military origin.

Recent controversial results for lowlevel exposure, risk estimates

1.4.2.2 Late effects of Radiation (Genetic)

Mutations: definition, types, potential hazards.

Low level radiation: sources, potential hazards, stochastic and deterministic (non-stochastic) effects, high background areas and cancer.

1.4.2.3 Effects of Radiation on Human Embryo & Fetus

Lethality, congenital abnormalities and late effects (Leukemia and childhood cancer), severe mental retardation. Doses involved.

1.4.2.4 Biology and Radiation Response of Tumors

Tumors growth: Kinetics of tumor response. Growth fraction, cell loss factor.

Volume doubling times, potential volume doubling times, repopulation, and accelerated repopulation.

Radiocurability: definition, factors involved, tumor control probability curves

Factors determining tumor regression rates. Causes of failure to control tumors by radiation: tumor related, host related technical/mechanical errors.

Relationship between clonogen numbers and tumor control probability. Local tumor control and impact on survival.

1.4.3 Applied Radiobiology

Fractionation : rationale, factors involved (4 R's)

Time, Dose and fractionation relationshipL isoeffect curves, isoeffect relationships, e.g; NSD, CRE formalisms and their limitations, partial tolerance, means of summing partial tolerance, steepness of dose response curves.

Multi-target, two component and linear quadratic model. A/b ratios for acute and late effects and means for deriving these values. Isoeffective formulae. Clinical applications of the L-Q model.

Hyperfractionation, accelerated fractionation, hypofractionation, CHART, split dose treatments.

Brachytherapy – low dose rate, high dose rate and pulsed treatments.

Introduction to new techniques to optimize radio-curability; combination therapy (adjuvant surgery or chemotherapy), hyperthermia, hypoxic cell radio-sensitize, high LET radiation. Photodynamic therapy. The volume effect, general principles and current hypotheses.

Shrinking Field technique.

Combination Radiation-surgery

Pre-, post-and intra-operative radiation.

Rationale, radiobiological factors, current clinical results.

Irradiation of sub-clinical disease, debulking surgery, importance of clonogen numbers.

Combination Radiation-Chemotherapy

Definitions of radiosensitiser, synergism, potentiation, antagonism,
Radiosensitisers: types, mechanism.

Hyperthermia

Sources, rationale(historical examples), advantages and disadvantages,
thermotolerance.

Cellular damage: comparison and contrast with radiation, thermal and non-
thermal effects of ultrasound, microwaves, radiofrequency, etc. general host
responses (immunology,metastases)

Use along with radiotherapy and chemotherapy: optimum sequencing of
combined modalities. Current limitations to the clinical use of hyperthermia.

1.4.4 High LET Radiation

Comparison and contrast with low LET radiation

Neutrons: Source (including ^{252}Cf) and boron neutron capture (outline only).
Advantages and disadvantages of neutrons, RBE values, hazards of low dose and
low energy neutron, use in radiotherapy, combination with low LET, current
clinical results.

Other high LET particles: protons, mesons, high-energy heavy nuclei, application
to radiotherapy, current clinical results.

1.5 Clinical trials – Statistical basis for planning & interpretation Clinical Trials.

- Advantages & disadvantages
- Retrospective & Prospective studies
- Controlled & uncontrolled trials
- Single blind & double blind studies
- Phase I,II & III trials
- Ethics (Helsinki declaration).

Planning a trial

- Establishing objectives – short term and long term
- Determining the appropriate criteria
- Establishing grounds for inclusion and exclusion of patients
- Determining how many treatment schedules are to be completed
- Determining the treatment schedules and any appropriate modifications
- Determining the method of allocation of treatment; the allocation ratio and the
method and timing of randomization
- Determining what measures are to be taken, how they will be taken, who will take
them, at what times (s) and where they will be recorded.
- Designing, the appropriate forms of documentation

- Determining the proposed duration of the trial , either in terms of a fixed closing date, or the entry of a predetermined number of patients.
- Establishing conditions under which the trial may be terminated earlier than planned & procedures for detecting these conditions.
- Re-assessing the proposed trial in terms of ethics, appropriateness to the short & long terms objectives, feasibility & the availability of resources.
- Writing the protocol
- Running a pilot study

2 Clinical Radiotherapy

2.1 Cancer Epidemiology & Etiology

- 2.1.1 Cancer Statistics- world wide & India
- 2.1.2 Cancer Registries & National Cancer Control Programme
- 2.1.3 Analysis of data in cancer registries
- 2.1.4 Regional Cancer Centers
- 2.1.5 Cancer Screening & Prevention

2.2 Patient Care

- 2.2.1 Assessment & referral systems for radiotherapy
- 2.2.2 Diagnosis & workup
- 2.2.3 Staging
- 2.2.4 Care & evaluation during & after treatment
- 2.2.5 Emergencies in Oncology
- 2.2.6 Management of different malignancies

2.3 Treatment Response & Result

- 2.3.1 Guidelines for treatment response assessment.
Complete Response, Partial Response, No response, Stable disease.
- 2.3.2 End points of treatment results. Loco-regional control recurrence, metastasis, survival quality of life.
- 2.3.3 Treatment related morbidity assessment
 - i) Radiation morbidity (early & late)
 - ii) Morbidities of combined treatment
 - iii) Grading of morbidity

3 Clinical Chemotherapy

- 3.1 Basic Principles of chemotherapy
 - 3.1.1 Chemotherapy drugs
 - 3.1.2 Newer chemotherapeutic agents
 - 3.1.3 Basic for designing different chemotherapy schedules. Standard chemotherapy schedules.
 - 3.1.4 Chemotherapy practice in various malignancies
 - 3.1.5 Chemotherapy practice & results/toxicities in sequential & concomitant chemoradiotherapy.
 - 3.1.6 Supportive care for chemotherapy.

3.1.7 The basic principles underlying the use of chemotherapeutic agents.

- i) Classification and mode of action of cytotoxic drugs. The principles of cell kill by chemotherapeutic agents, drug resistance, phase specific and cycle specific action.
- ii) Drug administration. The general principles of pharmacokinetics; factors affecting drug concentration 'in vivo' including route and timing of administration, drug activation, plasma concentration, metabolism and clearance.
- iii) Principles of combinations of therapy, dose response curves, adjuvant and neo-adjuvant chemotherapy, sanctuary sites, high dose chemotherapy, and regional chemotherapy.
- iv) Toxicity of drugs. Early, intermediate and late genetic and somatic effects of common classes of anticancer drugs. Precautions in the safe handling of cytotoxic drugs.
- v) Endocrine manipulation and biological response modifiers. An understanding of the mode of action and side effects of common hormonal preparations used in cancer therapy (including corticosteroids). Use of the major biological response modifiers such as interferons, interleukins and growth factors and knowledge of their side effects.
- vi) Assessment of New Agents. Principles of phase I, II, and III studies.
- vii) Gene Therapy

3.2 Other Disciplines Allied to Radiotherapy and Oncology

3.2.1 Surgical Oncology

- 3.2.1.1 Basic principles of surgical oncology, biopsy, conservation surgery, radical surgery, palliative surgery.
- 3.2.1.2 Basics of surgical techniques – head & neck, breast, thorax, abdomen, gynecological, genitourinary, musculoskeletal, CNS.
- 3.2.1.3 Combined treatments: with radiotherapy, chemotherapy, and hormone therapy.

3.2.2 Preventive Oncology

4 Palliative Care –

- 4.1 Guidelines for palliative care
- 4.2 Symptoms of advanced cancer
- 4.3 Management of terminally ill patients.
- 4.4 Different pharmacologic & non-pharmacology methods
- 4.5 Pain control, WHO guidelines for adults & children
- 4.6 Palliative radiotherapy
- 4.7 Palliative chemotherapy

- 4.8 Home care
- 4.9 Hospice care
- 4.10 Physical, social, spiritual & other aspects.

5 Research, Training & Administration

5.1 Research in Oncology

- 5.1.1 How to conduct a research
- 5.1.2 Guidelines for biomedical research: Animal studies, drug studies, human trial.
- 5.1.3 Cancer clinical trials. Phase I/II,III
- 5.1.4 Ethics of clinical research, ICMR 200 guidelines (updated time to time)
- 5.1.5 Evidence based medicine

5.2 Training in Oncology

- 5.2.1 Residency in Radiotherapy and Oncology
- 5.2.2 Theory, clinical & practical modes of training
- 5.2.3 Structured training : lectures, seminar, Journal club, Ward-round, Physics demonstration, Practical, Case Presentations (e.g. Long Case; short case)
- 5.2.4 Participation in various procedures, techniques (e.g. Brachytherapy, Radiotherapy Planning, Mould Room Procedures e.t.c)
- 5.2.5 CME-conference, symposium, workshop, seminar (including CME)
- 5.2.6 Visiting other cancer centers & clinical oncology departments sponsored by NBE.

5.3 Administration in Radiotherapy and Oncology

- 5.3.1 Clinical Oncologists role as an administrator
 - 5.3.2 How to set up a Radiotherapy and Oncology department, planning of infrastructure, & equipments
 - 5.3.3 Role in National Cancer Control Programme (NCCP)
 - 5.3.4 Responsibilities towards safety & quality assurance.
- Administration aspects of training, academic, patient care & research.

6.Training in Radiology

- 6.1.CT scan delineation of subsites and nodal stations in Head and neck, Thorax and pelvis
- 6.2;CT scan of Brain with special skills to delineate critical structures in the brain.
- 6.4:MRI of the Brain and pelvis for delineating volumes of normal structures .

COURSES

Course - I Basic Sciences (MDRT1)

CO1: Knowledge of applied Anatomy and Physiology as required in the practice of Radiotherapy practice.

CO2: Knowledge and skill in various investigative and imaging procedures including radio-isotope based procedures in diagnosis, staging, treatment planning and follow up.

CO3: Knowledge of the pathology of benign and malignant diseases.

CO4: Knowledge of staging of various cancers.

CO5: Knowledge of international coding and classification of various neoplastic disorders.

Anatomy

Knowledge of surface anatomy pertaining to Oncology

Detailed knowledge of the all organs

Detailed knowledge of the lymphatic system of all organs-regions

Practical familiarity with the radiographic appearance of important regions (living anatomy)

Cross sectional anatomy

Pathology

--General Pathology

--**Definitions of & distinction between different types of growth disorders (i.e; distinction between hyperplasia, hypertrophy, regeneration, malformation & neoplasia)**

--Malignant transformation-

Initiation & promotion stages of carcinogenesis.

Mode of origin- monoclonal, polyclonal, unifocal, multifocal

Structural & functional changes in the cellular components

Etiology, mechanisms of carcinogenesis, known types of carcinogens & their effects upon the cell. The relative importance of different factors in the causation of human cancer.

--Rate of growth, methods of measurement

Factors affecting growth rate

Mechanisms of spread

Local effects of tumors

Local & systemic reactions to tumors

Effects of therapy on tumors & normal tissues

Criteria for tumor diagnosis-macroscopic, histological & cytological uses & value of biopsy material

Classification of tumors – histogenic, histological, behavioral & immunological

Nomenclature – solid tumors, lymphoproliferative disorders.

Structure & organization of tumors- vascular supply, stroma etc.

Systems of grading

Endocrine aspects of malignancy:- Production of hormones by tumors, effect of hormones on tumors, paracrine effects of tumors

Paraneoplastic syndromes

Etiology of cancer

Course - II Principles of chemotherapy and its Clinical Applications (MDRT2)

CO1: Knowledge of radiation physics as applicable in radiotherapy practice.

CO2: Knowledge of radiobiology as applicable in the practice of radiotherapy.

CO3: Knowledge of radiation pathology as applicable in the practice of radiotherapy.

CO4: Basics of chemotherapy, including classification, rationality, dosages/modes/routes and complications/adverse effects.

Clinical Chemotherapy

Basic Principles of chemotherapy

Chemotherapy drugs

Newer chemotherapeutic agents

Basic for designing different chemotherapy schedules. Standard chemotherapy schedules.

Chemotherapy practice in various malignancies

Chemotherapy practice & results/toxicities in sequential & concomitant chemoradiotherapy.

Supportive care for chemotherapy.

Adverse effects of chemotherapy

The basic principles underlying the use of chemotherapeutic agents.

Chemotherapy vs radiotherapy for malignancies

-Classification and mode of action of cytotoxic drugs. The principles of cell kill by chemotherapeutic agents, drug resistance, phase specific and cycle specific action.

-Drug administration. The general principles of pharmacokinetics; factors affecting drug concentration 'in vivo' including route and timing of administration, drug activation, plasma concentration, metabolism and clearance.

-Principles of combinations of therapy, dose response curves, adjuvant and neo-adjuvant chemotherapy, sanctuary sites, high dose chemotherapy, and regional chemotherapy.

Combination therapy in the treatment of cancers

-Toxicity of drugs. Early, intermediate and late genetic and somatic effects of common classes of anticancer drugs. Precautions in the safe handling of cytotoxic drugs.

-Endocrine manipulation and biological response modifiers. An understanding of the mode of action and side effects of common hormonal preparations used in cancer therapy (including corticosteroids). Use of the major biological response modifiers such as interferons, interleukins and growth factors and knowledge of their side effects.

-Assessment of New Agents. Principles of phase I, II, and III studies.

-Gene Therapy

Course - III Principles of Radiotherapy Practice and Clinical Applications (MDRT3)

CO1: Knowledge of clinical practice of radiotherapy and oncology.

CO2: Knowledge of surgical oncology and medical oncology.

CO3: Knowledge about radiotherapy of benign disease.

CO4: Knowledge about the complications of treatment.

Clinical Radiotherapy

CO5: Skill in symptom control and containing care.

Cancer Epidemiology & Etiology

Cancer Statistics- world wide & India

Identification of risk factors and associated factors

Cancer Registries & National Cancer Control Programme

Analysis of data in cancer registries

Regional Cancer Centers

Cancer Screening & Prevention

Role of brachytherapy

Determining the number of cycles of chemoradiation

Applied Radiobiology

Eractionation : rationate,factors involved (4 R's)

Time, Dose and fractionation relationshipL isoeffect curves, isoeffect relationships, e.g; NSD, CRE formalisms and their limitations, partial tolerance, means of summing partial tolerance, steepness of dose response curves.

Multi-target, two component and linear quadratic model. A/b ratios for acute and late effects and means for deriving these values. Isoeffective formulae. Clinical applications of the L-Q model.

Hyperfractionation, accelerated fractionation, hypofractionation, CHART, split dose treatments.

Brachytherapy – low dose rate, high dose rate and pulsed treatments.

Introduction to new techniques to optimize radio-curability; combination therapy (adjuvant surgery or chemotherapy), hyperthermia, hypoxic cell radio-sensitize, high LET radiation. Photodynamic therapy. The volume effect, general principles and current hypotheses.

Shrinking Field technique.

Combination Radiation-surgery

Pre-, post-and intra-operative radiation.

Rationale, radiobiological factors, current clinical results.

Irradiation of sub-clinical disease, debulking surgery, importance of clonogen numbers.

Course - IV Recent Advances in Oncology (MDRT4)

CO1: Knowledge of recent advances in various fields as applicable to oncology.

CO2: Uptodate knowledge about recent published articles in the field.

CO3: Immunotherapy and role of monoclonal antibodies in diagnosis, staging and management.

CO4: Advances in care and nursing of patients on Radiotherapy and Chemotherapy.

Advancements in Radiation Oncology:

Virtual Simulation: Principle, CT Simulation, TPS based virtual simulation, Differences, Merits and Demerits, Practical considerations

Conformal radiotherapy(CRT):

Principles, Advantages over conventional methods, Essential requirements for conformal radiotherapy.

Knowledge about latest research papers in an international settings and its application in todays world

Course V Soft Skills (MDRT5) – Elective Course

CO1: The attitude to be a lifelong learner.

CO2: The competence to do a clinical research and write a thesis/dissertation under supervision.

CO3: The skill to communicate with patients, caregivers and colleagues, based on foundation of ethics, and etiquette.

CO4: Teaching skills.

CO5: The ability to be a leader/member of a healthcare 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.

LOG BOOK

RECORD OF TRAININGS

1. Name of Candidate :

2. Name of Hospital/Institution :

3. Enrolled in DNB :

(Name of the Speciality / Superspeciality)

4. Years of Training :

5. Name of Training :

6. Name of guide :

7. Name of Head of the Department :

8. Name of Medical :

Director/Superintendent

9. Thesis / Dissertation Topic :

Date : _____

Signature of Supervising Specialist

Teletherapy Planning

Date	Case Planned	Sign of candidate	Sign of Consultant in Charge	Countersign by HOD

Brachytherapy Planning

Date	Procedure Done	Sign of candiate	Sign of consultant In-charge	Countersign by HOD

Manual Planning with Isodose Chart

Date	Case Planned Planning	Sign of candidate	Sign of consultant Incharge	Countersign by HOD

Training in QA of machines

Date	Name of QA & machine	Sign of candidate	Sign of Physicist Consultant incharge	Countersign by HOD

Training in Handling Accessories

Date	Accessory Handled	Sign of candidate	Sign of Physical Consultant In charge	Countersign by HOD

Training in Radiation Safety

Date	Radiation Safety Procedure done	Sign of candidate	Sign of RSO Consultant in charge	Countersign by HOD

Training in Chemotherapy for solid tumors and Lymphoreticular Malignancies

Date	Malignancy	Chemotherapy regime used	Sign of candidate	Sign of consultant	Countersigned by HOD

Seminars

Date	Topic	Sign of Candidate	Sign of Consultant	Countersigned by HOD

Journal Club

Date	Topic	Sign of Candidate	Sign of Consultant	Countersigned by HOD