PG SYLLABUS FOR MD (RADIOTHERAPY)

1. BROAD GOALS

The students after successful completion of their training should be able to provide comprehensive cancer care and empowered for the future development of the specialty.

2. PROGRAMME OBJECTIVES

Postgraduate students should be well conversant and trained in:

1. Specialized oncology care pertaining to the needs of cancer patients.
2. The management of cancers prevalent in Indian subcontinent.
3. Basic knowledge 'research methodology' enabling him/her to develop, conduct and interpret clinical trial and investigations.
4. Exposure to epidemiology including relevant statistical methods used in analysis of clinical data, Descriptive and Analytical Epidemiology.
5. Delivery of radiation and in-depth technical knows how of equipment as well as physics and sequelae related to radiotherapy and oncology.
6. Technical skill in the use of cytotoxic agents for treatment of cancer.
7. Knowledge and application of genetic and Molecular Oncology.

8. Familiarity with role of surgery in management of oncological cases.
9. Planning and setting up specialty department of radiotherapy and oncology and interaction with government machinery.
10. Information Technology in Oncology
11. Geriatric Oncology
12. Care of Terminally ill cancer patients.
13. Knowledge of medical education technology for training of undergraduate and paramedical staff.
14. In summary doctors doing post graduation (MD) in the specialty of radiotherapy should be able to deliver complete cancer care including preventive aspects and development of new facility on independent basis.

3. POSTGRADUATE TRAINING

- **Standard Requisite**
- **Teaching**
- **Administration**

Standard Requisite

I. **Basic Sciences**

II. **Clinical Sciences**

III. **Research**

I. Basic Sciences: Minimum undergraduate level training in anatomy, physiology, biochemistry microbiology, pathology & pharmacology relevant in clinical practice, in addition to specific emphasis on basic genetic and molecular biology related to tumor and clinical oncology.

II. Clinical Sciences: (Radiotherapy, Chemotherapy and related discipline): Theoretical background including recent advances is prerequisite for clinical training of PG's -

a. Become competent in taking patient's history of illness and able to identify possible etiological/predisposing factors.
b. Should develop skills to interpret and elicit various physical signs and to arrive at a probable diagnosis and to decide on cost effective diagnostic procedures.
c. Carryout usual clinical interventions in the management of oncology patients like FNAC, pleural aspiration, abdominal paracentesis, bone marrow aspiration, Central venous lines and biopsy etc.
d. Acquainted with basic methodological & interpretation of various diagnostic tests and procedures.
e. Seminars, symposia, reviews, ward round & post graduate interactive group discussion should constitute methodology of their training.
f. Able to provide palliative and terminal care for cancer patients.

III Research: A post graduate student pursuing the specialty of radiotherapy-

a. Should have knowledge of the basic scientific methodology, statistical basis and cancer epidemiology.
b. Should be able to devise, prepare and carry out research project 'individually'.
c. Should be able to decide the relevance of any study/analysis on the subject
d. Should develop a skill to present data in the form of research paper at conference /symposia/CME etc.
e. Should know the basic concepts of Indexing and international classification of disease, tumour registry systems, department tumor registry.The student should also know about the UICC, IACR system for Methodology of follow up and patient retrieval system that forms the foundation of clinical research follow up based expertise

Teaching

a. Should verse with method of teaching using audio-visual aids
b. Should be able to conduct demonstration and teaching for under graduate students
c. Should be able to collect, compile and present the material and data for scientific and public lectures pertaining to radiotherapy and oncology.

Administration

A post graduate student should be involved in managing the day to day affairs related to patient treatment, care, academics, and research. He/she must have knowledge of planning and setting up an oncology department, interaction with government machinery

and other agencies , experience of National Cancer Control Programme.cts of training, academic, patient care & research.

4. SCOPE OF TRAINING

- **Clinical training**
- **Clinical procedures**
- **Research training**
- **Teaching**

Clinical Training

Posting

1. Major tenure of posting should include care of inpatients, out patients, day care, isolation, special clinics, terminally ill patients and maintenance of case records for both in & out patients
2. Linear Accelerator
3. Simulator
4. CT simulator
5. Brachytherapy LDR/MDR/HDR/PDR
6. Computerized TPS
7. Mould room
8. Medical physics lab

III Following support department posting is also desirable: -

1. Pathology
2. Radio diagnosis
3. Nuclear Machine
4. Gynecology, GI surgery, Otorhinolaryngology, Neurosurgery and Pulmonary medicine.
5. Molecular Oncology and genetics.

Total duration of posting in support department shouldn't exceed 12 weeks.

B. Basic clinical training should rest on day to day working in care of both in & out patients, day care chemotherapy, radiotherapy treatment planning (both manual & TPS) and execution, training in Quality Assurance of machines. The common tumors should be discussed at length in the teaching ward rounds. Each individual should present and discuss the respective case problems.

C. There should be intra and inter departmental meeting for discussion the uncommon/interesting cancer cases.

D. In addition to above the following are suggested as some of the activities to impart clinical training & skills:-

1. Various Topics should be discussed in interactive seminars.
2. In depth clinical presentation by individual – minimum desirable of at least 20 session during the term
3. In depth review of at least 5 sessions.
4. Critical evaluation of journals/ research articles –5 sessions.

E. Attending various accredited scientific meeting - CME/Symposia/conference-30 hours.

F. Training in patients' record keeping, hospital based and city tumour registry system, cancer notification and WHO recommendations on improving follow up

Clinical Procedures

A log book must be maintained by the post graduate student, to record various procedures done by the him/her e.g. Needle aspirations, bone marrow biopsy, radiotherapy treatment, Brachy therapy application, planning & administration of drugs etc). Intrarvesical / rectal drug delivery, cystoscopic inspections, insertion of central venous line and interventional radiological sessions pertaining to the patient. Knowledge of Surgical procedures as part of comprehensive oncological management

Research Training

Collection of information related to advances in medicine from various sources (use of library, multimedia, internet etc.) their interpolation and application.

Teaching

1. Undergraduate clinical demonstration of minimum 3 sessions
2. Demonstration and teaching for nursing students.

3. Patient /Public education talks and preparation of multi-media presentation, material, articles, lectures, pamphlets & books.

5. EVALUATION

5.1 INTERNAL ASSESSMENT

5.2 UNIVERSITY ASSESSMENT

5.1 INTERNAL ASSESSMENT

A . Internal Assessment:

- Should constitute at least 25% of marks in the final clinical assessment
- Should be based on :
    1. Day to day 'working as a resident doctor in the hospital.
    2. Log book
    3. General attitude towards the patients.
    4. Competence in using radiotherapy, chemotherapy and combined treatment modalities.
    5. Grading done for clinical presentation, reviews, seminar, journal reading/presentation.
    6. 'Sent up' examination performance

B. Mid term assessment: Should be held at the end of two years in the subject of basic sciences relevant to radiotherapy and other topics related to oncology and Radiotherapy. Twenty five percent of final examination marks should be from this

examination that should be inform of a sent up examination with theory and viva voce mock exams.

c. UNIVERSITY ASSESSMENT

Theory syllabus

Paper I

Paper II

Paper III

Paper IV

Paper – I

Radiation Physics and Basic Sciences related to Radiotherapy- Pathology, Anatomy, Biochemistry, etc.

A. Basic Science related to radiotherapy:

Theory

a. Basics of anatomy relevant to clinical practice ie. surface anatomy of various viscera, microanatomy, important structures/organs anatomical location in the body , details of lymphatic system of all regions , cross sectional anatomy.

b. Basic functioning of various organ system, central of vital functions, pathophysiological alternation in diseased states, interpretation of symptoms & sign in relation to pathophysiology.

c. Pathological changes in various organs associated with tumors & their correlation with clinical signs, understanding of various pathogenic processes and possible

therapeutic intervention, possible distinction between different types of tumors , grading immunological effects & genetic alterations.

d. Knowledge about various microorganisms important for their pathogenic potential, important organism commonly seen in clinical practice, levels of therapeutic interventions possible in preventing and /or eradicating organism.

e. Knowledge about pharmacokinetics & pharmacodynamics of the Cytotoxic and other drugs used for the management of cancer & common problems in a person & in a patient with disease kidneys /liver etc which may result in alternation in metabolism/excretion of the drugs; rationale use of available drugs.

B. **Physics Related to Radiotherapy**

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 quantization, Relationship between wavelengths, Frequency, Energy.

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

Production of X-rays: The X-ray tube, Physics of X-ray production, continuous spectrum, characteristic spectrum, Effective of X-ray production, Distribution of X-rays in space, specifications of beam quality, Measurement of beam quality, filters and filtration.

Interaction of radiation with matter: Attenuation, scattering, absorption, Transmission, Attenuation coefficient, Half Value (HVL), Energy transfer, Absorption and their coefficients, Photoelectric effect, Compton effect, Pair-production, relative importance for different attenuation processes at various energies.

Electron interactions with matter: Energy loss mechanism - Collis ional losses, radioactive losses, Ionisation , 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.

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

Exposure, Dose, Kerma: Definitions Units (old, new), Inter-relationships between units variation with energy and material. Measurement of exposure (Free are chamber, Thimble chamber,) Calibration of therapy beams: Concepts, Phantoms, protocols (TG 21, IAEA TRS-277, TG 51) dose determination in practice (brief outline only, details not required)

Radiotherapy Equipment:

Grenz ray, contact, superficial orthovoltage and Deep therapy, super voltage, Mega Voltage therapy.Therapy and diagnostic X-ray units-comparison. Filters, factors affecting output, principle of cooling, Betatrons.

Co-60 units : Comprehensive description of the unit, Safety mechanism, 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 typical unit, CT Simulator
Basic ratios, Factors, Dose distribution, Beam modifications and shaping in

Teletherapy Beams

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

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

Equivalent square concept, surface dose (entrance and exist), skin sparing effect, Output factors.

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

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

Body in homogeneities: 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 , Inbuilt Universal , Dynamic /Virtual), Wedge Isodose curves

Other beam modifying and shaping devices: Methods of compensation for patient contour variation and /or tissue in homogeneity- Bolus, Buildup material, Compensators , Merits and Demerits. Shielding of dose limiting tissue: Non-divergent and Divergent beam blocks, Independent jaws, Multileaf collimators, Merits and Demerits

Principles of Treatment Planning – I

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

Methods of correction for beams's oblique incidence, and body in homogeneities

SSD technique and Isocentric (SAD) technique: Description and advantages SAD technique.

Combination of field: 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). Example of above arrangements of fields in 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.

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 disk, direct link with CT, MR). 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.

BATHOS as applied to linear accelerator calculations modified BATHOS as applied to clinical radiotherapy

Alignment and Immobilization : External and internal reference marks , Importance of Immobilization in radiotherapy , Immobilization methods (Plaster or Paris casts, Perspex casts, bite blocks, shells , head rests, neck rolls , Alpha –Cradles, Thermoplastic materials , polyurethane foams), Method of beam alignment (Isocentric marks , laser marks and front/ back pointers).

Treatment execution: Light field, Cross hair, ODIS, scales in treatment machines

Treatment verification: Port films, Electronic portal imaging devices, In-vivo patient dosimetry (TLD), diode detectors, MOSFET, film etc) changes in patient position, target volume and critical volume during course of treatment

Electron Beam Therapy

Production of electron beams: Production of electron beams 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 specification, variation of men energy with depth. Suitability of measuring instruments for electron beam dosimetry.

Treatment planning : Energy and field size choice, air gaps, and obliquity, Tissue in homogeneity 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

Physical Principles of Brachy therapy

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

Historical background: Radiation and Dose units: Activity used, Exposure, Absorbed Dose, Mg-hr curie, Radium equivalent, roentgen, rad, gray. Source strength specification, Brachytherapy Dose calibration.

Technique: Pre-loaded, after loading (manual and remote) , Merits and Demerits, surface, Interstitial , Intracavitary, Intraluminal, Intravasular brachy therapy, Low, Medium , High and Pulsed dose rates. Remote after loading machines, detailed description of any one unit.

Dosage systems: Paris System, Stockholm system, Manchester system. Newly developed systems e.g.Monte Carlo algorithms etc.

Treatment Planning: Patient selection, volume specifications, Geometry of implant, Number, strength and distribution of radioactive sources, Sources localization, Dose calculating, 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 : Concept 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.

Quality Assurance in Radiotherapy (QART)

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

Quality Assurance of Simulator, TPS, Co-60, linear accelerator

Acceptance testing of simulator, TPS, Co-60, linear accelerator

Radiation Protection and Regulatory Aspects

Statutory Framework – Principle 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 Reasonable Achievable" (ALARA)

Personnel and Area Monitoring: Need for personnel monitoring, Principle 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 facilitiy (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 /bachytherapy sources(s). Construction of building, qualified staff, Procurement of instruments and accessories of unit and performance tests, Calibration of units, RP & AD approval for clinical commissioning of the unit.

Other regulatory requirements: Regulatory consent NOCs, periodical report to AERB and Radiological Physics and Advisory Division (RP & AD) Bhabha Atomic Research Centre (BARC).

Advancements in Radiation Oncology

Virtual Simulation: Principles, CT-simulation, TPS based 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 beans conforming to target shape
3. Stereotactic radiotherapy
4. Principle of inverse planning and Intensity Modulated Radiation Therapy (IMRT)
    - Using 3 D compensators

- Static IMRT (Step and shoot technique)
- Dynamic IMRT (sliding window technique
- Dynamic arc IMRT
- Micro-MLC
- Tomotherapy methods

5. Time gated (4 D) radiotherapy

Merits and demerits of IMRT

Stereo tactic irradiation methods : Physics principles, Techniques , Description of units (Gamma Knife and Linac based) Merits and demerits, stereo tactic Radio surgery (SRS) and stereo tactic Radiotherapy (SRT), whole body stereo tactic frame

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

Paper II

Urinary tract, Genital tract, Breast, Respiratory system, Childhood tumors, head & Neck, Mediastinum, Hematepoietic system, Geriatric Oncology.

1. Head & Neck

I. Combined modality therapy (Surgery/Radiotherapy /Chemotherapy) in advanced Sqyamous cell carcinoma of head & neck

II. Eye & Orbit

III. Nasopharynx

IV. Nasal cavity & paranasal sinuses

V. Salivary glands

VI. Oral cavity

VII. Oropharynx

VIII. Hypopharynx

IX. Larynx

X. Management of neck including malignancy of unknown origin

XI. Thyroid

XII. Cervical oesophagus

2. Thoracic Tumors

i. Lungs a. NSCLC

b. SCLC

ii. Thymus

iii. Oesophagus

iv. Mediastinum

v. Tracheal Tumours

vi. Penicardial and Myocardinal Tumours

3. Breast

i. Breast screening

ii. Breast cancer prevention

iii. Early breast cancer

iii. Locally advanced

iv. Recurrent breast cancer

v. Metastatic breast cancer

vi. Breast conservation/preservation

vii. Benign and borderline breast diseases

4. Genitourinary Tract

i. Kindey, renal pelvis and ureter

ii.Bladder

iii.Supra renal

5. Male genitourinary tract

i. Low risk prostate cancer

ii. Intermediate & high risk prostate cancer

iii. Testis

iv. Penis & male urethra

6. Female genito urinary tract

i. Methods of Mass cancer cervix campaign (screening and prevention)

ii. Cervix

iii. Endometrium

iv. Ovary & Fallopian Tubes

v. Trophoblastic tumours

vi. HPV vaccine

7. Hematological Tumours

i. CLL

ii. CML

iii. ALL

iv. AML

v. Other leukemia

vi. Multiple Myeloma

9. Lymphomas

i. Hodgkin’s Disease

ii. Non-Hodgkin’s Lymphoma

iii. Cutaneous T-cell Lymphoma

iv. Rare lymphomas

10. Pediatric tumors

i. Pediatric ALL

ii. CNS Tumors in children

iii. Wilms tumors

iv. Neuroblastoma

v. Rhabdomyosarcoma

vi. PNET

vii. Lymphomas in children

viii. Rebinoblastoma

11. Geriatrics Oncology

i. Fundamentals of Geriatric Oncology

ii. Common Geriatric malignancies

iii. Management of Geriatric malignances

iv. Socio economic aspects of geriatric Oncology

Paper III

Skeletal system, Reticulo-endothelial system, central nervous system, skin, Gastro Intestinal Tract, Principles of Cancer Chemotherapy , Details of practice of Cancer chemotherapy as applied to human malignancies, Molecular and Genetic Oncology.

1. Sarcomas of bone and soft tissues

i. Osteosarcoma

ii. Soft tissue sarcoma – 1. Rhandomyosarcoma

2. Leiomyosarcoma

3. Fibrosarcoma

iii. Chondro sarcomas

iv. Giant cell tumors

v Synovial sarcoma

vi. Other malignant diseases of bone e.g. Paget's disease etc

vii. Non malignant disease

2. Primary Intra Cranial Tumors

i. Low grade Gliomas

ii. High Grade Gliomas

iii. Pituitary

iv. Spinal canal

v. Ependymoma and other adult brain tumors

vi. Medulloblastoma

3. Skin

Skin:

i. Epidermal

ii. Melanotic

iii. Appendeges (Sweat glands, hair follicles etc)

AIDS related malignancy-

4. Gastro Intestinal Tumors

i. Oesophagus

ii. Stomach and small intestine

iii. Pancreas

iv. Liver & hepato-biliary tract

v. Colon and rectum

vi. Anal canal

5. **Cancer Chemotherapy –Clinical chemotherapy. Principles of Cancer Chemotherapy. Details of practice of Cancer chemotherapy as applied to treatment and management of cancer.**

1. Cancer Chemotherapy drugs
2. Newer Cancer chemotherapy agents
3. Basis for designing different cancer chemotherapy schedules. Standard cancer chemotherapy schedules
4. Chemo-sensitization
5. Fundamental basis of chemo-radiation
6. Chemotherapy practice in various malignancies
7. Chemotherapy practice and results/toxicities in sequential and concomitant chemoradiotherapy.
8. Supportive care for Chemotherapy
9. Supportive care in chemo-radiation
10. The basic principles underlying the use of chemotherapeutic agents
    1. Classification and mode of action of cytotoxic drugs. The principles of cell kill by Chemotherapeutic agents, drug resistance, phase specific and cycle specific action
    2. Drug administration. General principles of pharmacokinetics, factors affecting drug concentration ‘in vivo ‘ including route and timing of administrations , drug activation, plasma concentration , metabolism and clearance.

3. Principles of combination of therapy, dose response curves, adjuvant and neoadjuvant chemotherapy, sanctuary sites, high dose chemotherapy and regional chemotherapy.
4. Toxicity of drugs, early, intermediate and late genetic and somatic effects of common classes of anticancer drugs. Precaution in the safe handling of cytotoxic drugs.
5. Endocrine manipulation and biological response modifiers. An understanding of the mode of action and side effects of common hormonal precautions used in chemotherapy (including corticosteroids). Use of the major biological response modifiers such as interferon's interleukings and growth factor and knowledge of their side effects.
6. Assessment of new agents. Principles of Phase I, II and III studies.
7. Gene therapy.
8. Chemo toxicity & response modifiers

6. Molecular and Genetic Oncology.

1. Cell cycle- DNA repair; apoptosis.
2. Invasion and metastasis, angiogenesis and lymphangiogenesis.
3. Cell signaling and interactive networks.
4. Immune response.
5. Gene Therapy
6. Somatic correction of gene defect
7. Genetic pro-drug activation
8. Genetic immunomodulation

15. **Immunotherapy.**

1 Monoclonal antibody therapy

2 Radioimmunotherapy

3 Advances in immunotherapy

PAPER – IV

Radiotherapy including radiobiology, Radioactive, isotopes, recent advances, imaging system and their use in the treatment planning, benign diseases, palliative & supportive care.

Radiobiology

Introduction of Radiation Biology

Interaction of Radiation 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.

Introduction to factors influencing radiation response.

Physical factors: dose, dose quality, dose rate temperature

Chemical factor: Oxygen, radio sensitizers, radio protectors

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

Host factors: Partial and whole body exposure.

Relevance of radiation biology in radiotherapy.

Interaction of ionizing radiation on mammalian cells.

The cell: Structure and function; relative radio sensitivity of nucleus and cytoplasm, mitosis, cell cycle, principle of DNA, RNA and protein synthesis, radiation effects on

DNA , strand breakage and repair, common molecular biology and repair, common molecular biology technique.

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 ^{252}Cf. Radiology of low, high dose rate & pulsed brachytherapy, hyper fractionation, significance in radiotherapy. Effect of low LET and high LET radiation on cell. Cell survival curves.

Effect of sensitizing and protective agents. 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 ; dose protection and LET, effects on the embryo and the fetus, life shortening, leukaemogenesis and carcinogenesis, genetic and somatic hazards for exposed individuals and population. Biological basis of radiological protection.

Organ radio sensitivity and radio responsiveness, concept of therapeutic index

Acute effects of 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

Radiation Effects on Major Organs/tissues

Acute & late effects on all normal organs & tissue 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.

Late effects of radiation (somatic)

Sterility, cataracts and cancer

Carcinogenesis: mechanisms in vitro and in vivo, oncogenes and antioncogenes.

Radiation induces cancer of occupational, medical or military origin.

Recent controversial results for low level exposure, risk estimates

Late Effects of Radiation (Genetic)

Mutations: definition, types, potential hazards.

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

Effects of Radiation on Human Embryo & Fetus

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

Biology and Radiation Response of Tumors

Tumor growth ; kinetics of tumor response. Growth fraction , cell loss factor .

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

Radio curability: 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 number and tumor control probability. Local tumor control and impact on survival.

Applied Radiobiology

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

Time, dose, and fractionation relationship: Isoeffect curves, isoeffect relationships, e.g NSD, CRE formalisms and their limitation, partial tolerance,

Means of summating partial tolerance, steepness of dose response curves.

Multi-target, two component and linear quadratic model . Alpha/beta ratios for acute and late effects and means of deriving this value. Isoeffective formulae. Clinical applications of the LQ model, hyper fractionation, accelerated fractionation, hypo fractionation, CHART, split dose treatments.

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

Introduction to new techniques to optmize radio-curability ; combination therapy (adjuvant surgery or chemotherapy), hyperthermia, hypoxic cell radio-sensitizers, high LET radiation. Photodynamic therapy.

The volume effect, general principle 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 radio sensitizers, synergism, potentiation, antagonism.

Radiosenistzers : type , mechanism

Hyperthermia

Sources, rationale (historical example), advantages and disadvantages, thermo tolerance. 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.

High LET Radiation

Comparison and contrast with low LET radiation.

Neutron source (including ^{252}Cf) and boron neutron capture (outline only).

Advantages and disadvantages of neutrons, RBE values, hazards of low dose and low energy 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, high energy heavy nuclei, application to radiotherapy , current clinical results.

2. Radio-active isotopes used for diagnosis and therapy

3. Benign diseases- Radiotherapy in non-malignant diseases

4. Imaging in oncology

5. Modern Trends /Recent Advances

i. Anti angeogenic factors , Angiogenesis & carcinogenesis

ii. Monoclonal Antibodies - MABs & NIBs

iii. Essentials of Genomics:

Genomes,

Signal translation,

Immunology,

Cytogenetic, cell cycle,

Apoptosis,

Invasion and metastasis

iv. Gene Therapy,

v. Molecular therapy,

vi. Cancer vaccines.

16.Palliative & supportive care –

- Palliation of compression and obstruction due to malignancy
- Palliation of brain & spiral cord metastasis
- Palliation of bleeding catastrophes
- Palliation of bone metastasis
- Palliation of visceral recurrences and metastases
- Pain management
- Patient's and relatives' counseling on end stage management

6. <u>Undergraduate training</u>

Undergraduates are posted in department as part of Radiology posting for seven days, during 4^{th} –5^{th} semester. At the end of posting they are assessed on following points:

- Presentation of common cancers in this region like head & neck, cervix, breast, brain lymphoma, lung, GIT bone & soft tissues, pediatrics.
- Thorough knowledge of following treatment modalities and their practical demonstration:
    a. Teletherapy
    b. Brachytherapy
    c. Chemotherapy
    d. Chemo-radiation
- Understanding the concepts of combined modality treatment and the significance of radiation and chemotherapy in comprehensive management of cancer.
- Sequelae associated with multimodality therapy and their management

- Preventive oncology and early detection of cancer.
- National cancer control programme,