King George's Medical University, U.P.
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Department of Radiotherapy
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किंग जार्ज चिकित्सा विश्वविद्यालय
उ0प्र0, लखनऊ–226003,(भारत)
रेडियोथेरैपी विभाग
फोन: 0522–2258650

Ref. No.....

Date.....

OFFICE THE DEAN
Ref. No. 4353
Dt. 14/12/21
K.G. Medical University, U.P. Lucknow

सेवा में,

अधिष्ठाता
एकेडमिक्स
किंग जार्ज चिकित्सा विश्वविद्यालय,
लखनऊ

महोदय,

कृपया अपने पत्र संख्या-Dean-Academics/KGMU/2021/3765 दिनांक 13.12.2021 का संदर्भ ग्रहण करें जो कि विभाग में संचालित पी0जी0 पाठ्यक्रम एम0डी0 के Curriculum प्रेषित किये जाने से सम्बन्धित है।

उपरोक्त के सम्बन्ध में रेडियोथेरेपी विभाग से आपके पत्र संख्या-Dean-Academics/KGMU/2021/3153 दिनांक 09.07.2021 के संदर्भ में सदस्य सचिव, सूचना प्रौद्योगिकी सेल, के0जी0एम0यू0, लखनऊ को प्रेषित किया जा चुका हैं। उक्त से सम्बन्धित सूचना संलग्न कर पुनः आपकी सेवा में प्रेषित।

PG Curriculum

1. Learning outcomes
2. Syllabus
3. Teaching learning methods
4. Interdisciplinary training
5. Assessment methods

भवदीय

विभागाध्यक्ष
रेडियोथेरेपी विभाग
संलग्नक-उपरोक्तानुसार

प्रतिलिपिः Ref. No. 1006/RT/21 dt. 14/12/2021

- मा0 कुलपति महोदय जी के निजी सचिव को सूचनार्थ प्रेषित।

विभागाध्यक्ष
रेडियोथेरेपी विभाग

Department of Radiotherapy, KGMU, Lucknow

Learning outcome:

1. To knowing needs of cancer patients in terms of oncology care
2. Management of different malignancies with both curative and palliative intentions
3. Research project in form of thesis
4. Knowledge of statistical methods used in analysis of clinical data, Descriptive and Analytical Epidemiology
5. Knowledge of Radiation techniques in detail
6. Knowledge of Radiation physics
7. Knowledge of Radiation biology
8. Knowledge of chemotherapy and targeted therapy
9. Knowledge and application of genetic and Molecular Oncology
10. Planning and setting up specialty department of radiotherapy and oncology
11. Knowledge of palliative care
12. Knowledge of medical education technology for training of undergraduate and paramedical staff
13. Knowledge of preventive oncology
14. Knowledge of different government schemes and program of cancer care

Syllabus:

1. **Basic sciences curriculum**

(a) Anatomy

- Knowledge of surface anatomy pertaining to Oncology
- Detailed knowledge of the anatomy of all organs
- Detailed knowledge of the blood supply & venous drainage of all regions
- Detailed knowledge of the lymphatic system, blood supply and nervous drainage of all regions
- Practical familiarity with the radiographic appearance of important regions
- Cross sectional anatomy

(b) Pathology

I. General Pathology
- Definitions of & distinction between different types of growth disorders (i.e. distinctionamongmetaplasia, hyperplasia, hypertrophy, regeneration, malformation, metaplasia, anaplasia&neoplasia)

II. Systemic Pathology

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, behavioural & immunological
- Nomenclature - solid tumors, lymphomas, leukemias
- Structure & organization of tumors - vascular supply, stromaetc.
- Systems of grading
- Endocrine aspects of malignancy:- production of hormones by tumors, effect ofhormones on tumors, paracrine effects of tumors
- Paraneoplastic syndromes

Etiology of cancer

- Genetic predisposition, congenital syndromes
- Chromosomal abnormalities, hereditary tumours
- Protooncogenes, oncogenes, tumor suppressor genes, viruses &malignancy
- Multifactorial causation
- Nutritional aspects in cancer causation and prevention.
- Biological - protozoal, bacterial, viral
- Chemical - Classes of carcinogenic chemicals, smoking
- Physical - trauma, irradiation
- Common occupational cancers.

Tumor immunology

- Organization& development of the immune system
- Cellular basis of immunity
- Tumor immunity, tolerance, enhancement
- Immune surveillance hypothesis

- Immunological markers in diagnosis & monitoring
- Experimental & clinical immunotherapy
- The HLA systems

iii. Tumour markers

(c) Radiological Physics

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, Relationship between Wavelength, Frequency, Energy

Nuclear Transformations

Natural and artificial radioactivity isotopes isobars and isotones, Decay constant, Activity, Physical, Biological and Effective half-lives, Mean life, Decay processes, Radioactive series, Radioactive equilibrium

Production of X-rays

The X-ray tube, Physics of X-ray production, Continuousspectrum, Characteristic spectrum, Efficiency of X-ray production, Distribution of X-raysin space, Specifications of beam quality, Measurement of beam quality, Filters andfiltration overview of X-rays image formation

Interaction of radiation with matter

Attenuation, Scattering, Absorption, Transmission, stopping power 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,(RBE) 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 interaction of neutrons and other heavy ions with matter 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,Thermoluminescence, Visual Imaging (Film, Fluorescent screens), and their examples

Exposure, Dose, Kerma

Definitions, Units (Old &New), Inter-relationships between units, Variation with energy and material. Measurement of exposure (Free air chamber,Thimble

chamber), Calibration of therapy beams: Concepts, Phantoms, Protocols (TG21,TG43, IAEA TRS-277/398, TG 51) Dose determination in practice *(brief outline only, details not required)*

Radiotherapy Equipment

Grenz ray, Contact, Superficial, Orthovoltage or Deeptherapy,Supervoltage, Megavoltage therapy. Therapy and diagnostic X-ray units - comparison.Filters, factors affecting output, principles of cooling.Betatrons.

Co-60 units: Comprehensive description of the unit, Safety mechanisms, Source capsule

Linear accelerators: History, Development, Detailed description of a modern, dual mode linear accelerator, Linac head and its constituents, Safety mechanisms, Computer controlled linacs, Record and Verify systems FFF,RTRT and other newer modalities Relative merits and demerits of Co-60 and linac units

Simulators: Need, applications detailed description of a typical unit, Simulator CT

Basic ratios, Factors, Dose distributions, Beam modifications and Shaping inTeletherapy 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, Back Scatter Factor, Peak Scatter, Factor, Off-Axis Ratio, Variation of these parameters with depth, field size, sourceskindistance, beam quality or energy, beam flattening filter, target material. Centralaxis depth dose profiles for various energies.
- Equivalent square concept, Surface dose (entrance and exit), Skin sparing effect, Outputfactors

Practical applications

- Co-60 dose calculations (SSD, and SADtechnique),Acceleratorcalculations (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 ondose distribution. Dose within bone / lung cavities, Interface effects, Electronicdisequilibrium
- Beam modification devices Wedge filters and their use, Wedge angle, Wedge Factors, Wedge systems (External,In-built Universal, Dynamic / Virtual), Wedge isodose curves.
- Other beam modifying and shaping devices: Methods of compensation for patientcontour variation and / or tissueinhomogeneity - Bolus, Buildup material,

Compensators,Merits and Demerits. Shielding of dose limiting tissue: Non-divergent and Divergentbeam blocks, Independent jaws, Multileaf collimators, microleaf ,Merits and Demerits

Principles of Treatment Planning - I

- Treatment planning for photon beams: ICRU 50,62,83,110 and NACP terminologies. Determinationof body contour and localization: Plain film, Fluoroscopy, CT, MRI,fMRI, PET-CT,SPECT-CT Ultrasonography, Simulator based partial blocked fields and specialised field treatment.
- Methods of correction for beam's oblique incidence, and body inhomogeneities
- SSD technique and isocentric (SAD) technique: Descriptions and advantages of SADtechnique
- Combination of fields: Methods of field addition, Parallel opposed fields, Patient thicknessvs. Dose uniformity for different energies in a parallel opposed setup, Multiple fields (3fields, 4 field box and other techniques). Examples of above arrangements of fields inSSD and SAD techniques, Integral Dose
- Wedge field technique, Rotation Therapy (Arc, and Skip), Tangential fields. Beambalancing by weighting. Total and hemi-body irradiation. Field junctions abutment, comparison between manual and computer based planning

Principles of treatment planning – II (must know)

- Limitations of manual planning. Description of a treatment planning system (TPS): 2Dand 3D TPS. Radiation bean library, DICOM systems 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'sEye View (BEV), Dose calculation and display (Point dose, Isodose curves, Isodosesurfaces, Colour wash). Various Plan algorithms,(pencil beam, montocarlo, convolution) optimization, Plan evaluation tools: Dose-Volume Histograms (Cumulative and Differential), biological dose comparison(TCP,NTCP,BED,EUBD) Hard copy output, Storage and retrieval of plans.
- *Alignment and Immobilization:* External and internal reference marks, Importance ofimmobilization in radiotherapy, Immobilization methods (Plaster of Paris casts, Perspexcasts, bite block, shells, head rests, neck rolls, Alpha-Cradles, Thermoplastic materials,polyurethane foams), Methods of beam alignment (isocentric marks, laser marks, andfront/back pointers).
  (Should know)
- 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 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 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, Intra-operative Radiation Therapy

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,I-123, Sr-90, Yt-90, Ru-106, Ta-182, Cf-252 and other new radionuclides, Their complete physical properties, Radium hazards. Source construction including filtration, comparative advantages of these radionuclides.
- Historical background. Radiation and Dose units: Activity used, Exposure, Absorbed Dose, mg-hr, curie, milli-curie, milligram Radium equivalent, roentgen, rad,gray. Source strength specification, Brachytherapy Dose calibrator

  Techniques: Pre-loaded, after loading (manual and remote). Merits and Demerits. Surface, Interstitial, Intracavitary, Intraluminal, Intravascular brachytherapy. Low, Medium, Highand 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,ICRU 58,Image based planning
- Radiation Safety: Planning of brachytherapy facility, Rooms and equipment, Storageand Movement control, Source inventory, Disposal, Regulatory requirements
- Beta-ray brachytherapy including methods of use, Inspection, storage and transport ofsources, dose distribution
- Unsealed radionuclides: Concepts of uptake,I-131, Tc-99m and other isotopes distribution and elimination, Activitiesused in clinical practice, Estimation of dose to target tissues, and critical organs, Procedures for administering radionuclides to patients BNCT,PDT

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 Implementationof a Quality System
Quality Assurance of Simulator, TPS, Co-60, linear accelerator, brachytherapy
Acceptance testing of Simulator, TPS, Co-60, linear accelerator brachytherapy

Radiation Protection and Regulatory Aspects

Statutory Framework: Principles underlying International Commission on RadiationProtection (ICRP) recommendations. ICRP and National radiation protection i.e. AtomicEnergy Regulatory Board (AERB) standards. Effective dose limits (ICRP and AERB ICRP 60, 90,110).
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, and Survey meters
Regulatory aspects: Procedural steps for installation and commissioning of a newradiotherapy facility (Teletherapy and Brachytherapy) .cancer control program of government of India under the provisions of non-communicable disease Type approval of unit, Site plan, Layout ofinstallation / Associated facility: Primary, Secondary barriers, leakage and scatteredradiation. Regulatory requirement in procurement of teletherapy/brachytherapysource(s). Construction of building, Qualified staff, Procurement of instruments, andaccessories, Installation of unit and performance tests, Calibration of unit, RP&ADapproval for clinical commissioning of the unit.
Other regulatory requirements: Regulatory consent, NOCs, Periodical Reports to AERBand Radiological Physics and Advisory Division (RP&AD), Bhaba Atomic ResearchCentre (BARC) and AERB.

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.Image fusion, Biological target volume.
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 compensators
– Static IMRT (Step and shoot technique)
– Dynamic IMRT (sliding window technique)
– Dynamic arc IMRT, IGRT,VMAT,RTRT(Real time respiratory gated radio therapy)
– 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-Cyber Knife), Merits and demerits, Stereotactic Radiosurgery (SRS) and StereotacticRadiotherapy (SRT), Whole body stereotactic frame

Networking in radiotherapy: Networking of planning and treatment units in a radiotherapydepartment including Picture Archival Communication System (PACS), Advantages, PatientData Management DICOM based RT, Remote RT Planning

(d) Clinical Radiobiology and Molecular Biology

- Introduction to Radiation Biology.
- Radiation interaction with matter.
  Types of radiation.
  Excitation and ionization. Radiation chemistry: direct and indirect effects, free radicals, oxygen effect ratio (OER) 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 factors:** Oxygen,radio sensitizers, radio protectors
- **Biological factors:** type of organism, cell type and stage, cell Density and configuration,age, sex.
- **Host factors:** Partial or whole body exposure.

- Relevance of radiation biology to radiotherapy
- 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 onDNA, 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.Oxygeneffect: mechanism, hypoxia, OER, reoxygenation in tumors, significance in radiotherapy.Dose rate. Brachytherapy sources including Cf-252.Radiobiology of low, high doserate& pulsed brachytherapy, hyperfractionation, significance in radiotherapy.

Effects 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); itsdefinition 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 andthefetus, life shortening, leukaemogenesis and carcinogenesis, genetic and somatichazards for exposed individuals and population.Biological basis of radiological protection.

- Organ radiosensitivity and radio responsiveness, concept of therapeutic index.
- 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 inperipheral blood lymphocytes
  - Radiation accidents: typical examples
- Radiation Effects on Major Organs/tissues

Acute & late effects on all normal organs & tissues including connective tissue, bonemarrow, bones, gonads, eye, skin, lung, heart, central nervous system tissues, peripheralnerves, esophagus, intestine, kidney, liver & thyroid with special reference to treatmentinducedsequelae 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 anti-oncogenes Radiation induced 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 radiation: sources, potential hazards, stochastic and deterministic (nonstochastic)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, repopulation, and accelerated repopulation.
Radiocurability: definition, factors involved, tumor control probability curves. Factors determining tumor regression rates. Causes of failure to control tumors byradiation: tumor related, host related technical/mechanical errors. Relationship between clonogen numbers and tumor control probability.Local tumorcontrol and impact on survival.

- Applied Radiobiology

Fractionation: rationale, factors involved (4 R's).
Time, dose, and fractionation relationship: isoeffect curves, Isoeffectrelationships,e.g. NSD, CRE, TDF formalisms and their limitations, partial tolerance, means of summating partial tolerance, steepness of dose response curves.
Multi-target, two component and linear quadratic model.a/b ratios for acute and lateeffects and means of deriving these values.
Isoeffective formulae. Clinical applicationsof the L-Q model, hyperfractionation, accelerated fractionation, hypofractionation,CHART, split dose treatments Concept of BED, EUBED,TCP,NTCP.
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-sensitizes, highLET radiation.
Photodynamic therapy Image based brachytherapy
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 Ofclonogen 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.
  Course and High LET Radiation
  Comparison and contrast with low LET radiation.

- ✓ Neutrons: source (including Cf252) and boron neutron capture (outline only). Advantages and disadvantages of neutrons, RBE values, hazards of low dose and lowenergy neutron, use in radiotherapy, combination with low LET, current clinical results.
  Other high LET particles: protons, mesons, high-energy heavy nuclei, application toradiotherapy, current clinical results. Clinical application of protons therapy.

(e) 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),ICH,GCP,ICMR guidelines.

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 treatments; the allocation ratio and the method andtiming of randomization
- Determining what measures are to be taken, how they will be taken, who will take them, atwhat time(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 theentry of a pre-determined 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 termobjectives, feasibility & the availability of resources.
– Writing the protocol
– Running a pilot study

2. Clinical Radiotherapy

- ✓ Cancer Epidemiology &Etiology
  - Cancer Statistics –worldwide& India
  - Cancer Registries
  - National Cancer Control Programme.
  - Analysis of data in cancer registries.
  - Regional Cancer Centers
  - TCC-Tertiary Cancer Centres
  - Cancer Screening & Prevention.
  - National programme for prevention and control of Cancer, diabetes,
  - Cardio-vascular diseases & stroke (NPCDCS)
- ✓ Patient Care

  Assessment & referral systems for radiotherapy
  Diagnosis & workup.
  Staging
  Care & evaluation during & after treatment
  Emergencies in Oncology
  Management of different malignancies
- ✓ Treatment Response & Result

  Guidelines for treatment response assessment:
  - ❖ Complete Response (CR)
  - ❖ Partial Response (PR)
  - ❖ No Response (NR)
  - ❖ Stable disease (SD)

  End points of treatment results: Loco-regional control, recurrence, metastasis, survival, quality of life.
  Treatment related morbidity assessment
  - Radiation morbidity (early & late)
  - Morbidities of combined treatment
  - Grading Systems of toxicities.
  -

3. Clinical Chemotherapy

- ✓ Basic principles of chemotherapy
  - Chemotherapy drugs.
  - Newer chemotherapeutic agents.

- Basis for designing different chemotherapy schedules.
- Standard Chemotherapy schedules.
- Chemotherapy practice in various malignancies
- Chemotherapy practice & results/ toxicities in sequential &
- Concomitant chemo-radiotherapy.
- Supportive care for chemotherapy.
- Nano particle based chemotherapy,
- Molecular targeted chemotherapy including monoclonal antibodies

✓ The basic principles underlying the use of chemotherapeutic agents.

1. Classification and mode of action of cytotoxic drugs. The principles of cell killby chemotherapeutic agents, drug resistance, phase specific and cycle specific action.
2. 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.
3. Principles of combinations of therapy, dose response curves, adjuvant and neo-adjuvant 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. Precautions 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 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.
6. Assessment of New Agents. Principles of phase I, II, and III studies.
7. Gene Therapy cancer vexing

Preventive oncology

- Guidelines for palliative care
- Symptoms of advanced cancer
- Management of terminally ill patients.
- Different pharmacologic & non-pharmacologic methods
- Pain control, WHO guidelines for adults & children.
- Palliative radiotherapy, pelvic surgery
- Palliative chemotherapy
- Home care, Rehabilitation
- Hospice care
- Physical, social, spiritual & other aspects.
-

Teaching learning methods:

Research in Oncology

How to conduct a research

Guidelines for biomedical research: Animal studies, drug studies, human trial.

Cancer clinical trials Phase I/II, III

Ethics of clinical research

Evidence based medicine.

Academics

Residency in Radiotherapy and Oncology

Theory, clinical & practical modes of training

Structured training: lectures, seminar, Journal club, Ward-round, Physics demonstration,Practical, Case Presentations (e.g. Long Case; Short Case)

Participation in various procedures, techniques (e.g. Brachytherapy, Radiotherapy Planning, Mould Room Procedures etc.)

CME-conference, symposium, workshop, seminar

Visiting other cancer centers& radiotherapy departments

Interdisciplinary Training

- Teaching classes in surgical oncology
- Teaching classes in obstetrics and gynaecology
- Teaching classes in otorhinology
- Teaching classes in surgical gastroenterology
- Teaching classes in radiodiagnosis
- Teaching classes in endocrine surgery
- Teaching classes in pathology

Assessment methods

Internal Assessment:

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.

Midterm assessment:

At the end of two years in the subject of basic sciences

Multiple choice questions of subject

University Assessment:

Theory syllabus: Paper I, Paper II, Paper III and Paper IV

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रेडियोथेरैपी विभाग
फोनः 0522–2258650

Ref. No..1020/R.T./21...

Date..15/12/2021.....

सेवा में,

अधिष्ठाता
एकेडमिक्स
किंग जार्ज चिकित्सा विश्वविद्यालय,
लखनऊ

OFFICE TI
1136
Ref. No.
Dt. 15/12/20..
K.G. Medical University, U.P. Lucknow

महोदय,

कृपया अपने पत्र संख्या-Dean-Academics/KGMU/2021/3758 दिनांक 11.12.2021 का संदर्भ ग्रहण करें जो कि विभाग में संचालित बी.एस.सी. रेडियोथेरेपी पाठ्यक्रम के Curriculum प्रेषित किये जाने से सम्बन्धित है।

उपरोक्त के सम्बन्ध में रेडियोथेरेपी विभाग से बी.एस.सी. रेडियोथेरेपी पाठ्यक्रम के Curriculum आपकी सेवा में प्रेषित।

धन्यवाद।

भवदीय

(नवीन सिंह)
प्रो0जूनियर ग्रेड
कोर्स कोआर्डिनेटर
संलग्नक-उपरोक्तानुसार

(एम0एल0बी0भट्ट)
विभागाध्यक्ष

B.Sc. Radiotherapy Technology

1. Goal and Objective of the Program

Radiation therapy is one of the most common modes of treatment for cancer apart from surgery and chemotherapy. Radiotherapy technologists play an important role for optimizing health care delivery system in radiation oncology. The objective of the bachelor degree course in Radiotherapy Technology (B.Sc. RT) is to meet the requirements of growing demand for the trained & competent radiotherapy technologist in the country. With the development of new technologies for the treatment of cancer, the demand of competent Radiotherapy technologists has increased by many folds. Keeping this urgent requirement in mind, department of Radiotherapy, KGMU, Lucknow had taken the initiative to start B.Sc. (RT) course in the year 2015. The department is committed to impart quality training & teaching to the students of B.Sc. (RT) course. The course has been designed to provide the necessary basic tools & knowledge to meet the specific requirements of the discipline. Lectures as well as practical training (demonstrations, laboratory exercises, case studies) have been included as part of the curriculum.

2. Duration of Course

The duration of the course for B.Sc. (Radiotherapy Technology) course is three years.

3. Syllabus, including skills

Detailed syllabus of B.Sc. Radiotherapy Technology course is attached herewith

4. Teaching Learning & Assessment methods

Theory & Practical

5. **Examination Pattern:** Three annual examinations

1st Year

Theory Papers:

Two theory papers, each of three hour duration, carrying 100 marks each

1. Anatomy and Physiology
2. Radiological Physics and Radiation Protection
3. Practical and viva voce (100 marks)

2nd Year

Theory Papers:

Two theory papers, each of three hour duration, carrying 100 marks each

1. Radiation equipment, Dosimetry & Quality assurance tests
2. Radiographic Techniques
3. Practical and viva voce (100 marks)

3rd Year

Theory Papers:

Two theory papers, each of three hour duration, carrying 100 marks each

1. Radiotherapy Treatment techniques
2. Recent advances
3. Practical and viva voce (100 marks)
4. Dissertation on a given topic (100 marks)

B.Sc. Part – I

There shall be two theory papers of three hour duration carrying 100 marks each and practical and viva-voce of 100 marks.

Sr. No.	Theory	Paper	Marks
1.	Anatomy and Physiology	Paper - I	100 (50 marks for each subject)
2.	Radiological Physics and Radiation Protection	Paper - II	100
3.	Practical and Viva Voce*	Anatomy Physiology Radiological Physics	100 100 100

B.Sc. Part – II

There shall be two theory papers of three hour duration carrying 100 marks each and practical and viva-voce of 100 marks.

Sr. No.	Theory	Paper	Marks
1.	Radiation equipment, Dosimetry & Quality assurance tests	Paper - I	100
2.	Radiographic Techniques in Oncology	Paper - II	100
3.	Practical and Viva Voce*		100

B.Sc. Part – III

There shall be two theory papers of three hour duration carrying 100 marks each, practical and viva-voce of 100 marks and dissertation on a given topic carrying 100 marks.

Sr. No.	Theory	Paper	Marks
1.	Radiotherapy Treatment techniques	Paper - I	100
2.	Recent advances	Paper - II	100
3.	Practical and Viva Voce*		100
4.	Dissertation on a given topic		100

* Practical – 30 % Viva- Voce – 70 %

1st Year

Paper -1

Anatomy and Physiology

1. Introduction to human body & Anatomical Nomenclature
2. Cells and tissues of the body
3. Thorax and abdomen
4. Musculoskeletal system (Bones and joints)
5. Respiratory System
6. Circulatory System
7. Lymphatic System
8. Digestive System
9. Urinary System
10. Male Reproductive/ Female Reproductive System
11. Head & Neck
12. CNS

Paper –II

Radiological Physics and Radiation Protection

Basic Radiation Physics, X-Ray tubes & production of X-rays

Atomic structure, Nucleus, Atomic No., Electron orbit and energy levels, Isotopes and Isobars, Radioactivity, Radioactive decay, radioactive equilibrium, half life, alpha, beta and gamma emission. Sealed and unsealed sources, production of artificial radioactive isotopes. common radioactive elements and their properties. Units of radioactivity, exposure and absorbed dose. Type of Nuclear reactions, induced radioactivity; fission and fusion reactions, cross section

.....8 Lectures

X-ray tubes, prbduction of X-rays, transformer, properties of x-rays Continuous X-ray spectrum, Bremsstrahlung radiation, Characteristics x-rays, Filters, Quality of X-rays, Effect of voltage and current on the intensity of X-rays, Properties of X-rays.

.....4 Lectures

Physics of X-ray production – x-ray tubes, high tension circuits, properties of x-rays. Rectification and high tension circuits: meaning of rectification, principle of semiconductors, solid state rectifiers. The self rectified circuit, full wave four – rectifier circuits, shock proofing, X-ray tubes construction of fixed anode, x-ray tube (inserts & shield), filament design, anode design (fixed anode), method of cooling. Insulation and cooling problems in x-ray tubes. Care of the x-ray tube. Inherent filtration and additional inclination, grid controls. Types of target, the filament circuit, timers, safety devices and interlocks. Basic principles of megavoltage, x-ray machines, gamma ray equipment for therapy, high energy accelerators and size of focal spot or source.

.....8 Lectures

Interaction of radiation with matter

Photoelectric effect, `Compton effect, Pair production, Ionisation of matter, Energy absorbed from X-rays, X-rays scattering, X-rays transmission through the medium, Linear and mass attenuation coefficient, inverse square law HVT and TVT, Interaction of charged particle and neutrons with matter.

.....6 Lectures

Detectors & Measurement of Radiation

Ionisation of gases, Fluorescence and phosphorescence, Effect of photographic emulsion, Ionisation chambers, Proportional counters, GM Counters, Scintillation Detectors, Liquid scintillator, Pocket

Dosimeters, T.L Dosimeters and their use in personnel monitoring badges, Advantages and disadvantages of various detectors, appropriateness of different types of detectors for different types of radiation measurement.

.....8 Lectures

Principles of Radiation Protection & Radiation Units

Types and sources of ionizing radiation & radiation units, Flux, Fluence, Kerma, Exposure, Absorbed dose, Equivalent dose, Weighting Factors, Effective Dose, Natural Background Radiation, Occupational Exposure Limits, Dose limits to public

.....5 Lectures

Assessment of external and internal exposures

Philosophy of radiation protection, Effect of time, Distance and Shielding, Calculation to workload, Calculation of weekly dose to the Radiation worker and general public, good work practices in diagnostic radiology and/or radiotherapy practices (including Teletherapy and brachytherapy), Planning consideration for radiology and/or radiotherapy installation including work load, use factor & occupancy factors, effect of different shielding material, warning signs; quality assurance; commissioning survey and regulatory review. Medical exposures in diagnostic radiology & radiotherapy, Protection against occupational exposure. Design feature of installation, shielding calculation & safety interlocks

.....8 Lectures

II[nd] Year

Paper -1

Radiation equipment, Dosimetry & Quality assurance tests

Radiotherapy Simulator and CT Simulator: General principle, parts and construction. Types of simulator. Types of imaging formats. Layout and plan of simulator room. Routine checks and maintenance.

Mould room equipment: Block cutting and shield making devices. Types of immobilization devices, shields and shielding materials. Bolus and compensator. Preparation of permanent ink.

Shielding: Shielding and shielding materials. Casting and fabrication. Management of pollution.

Telegamma Unit: Stationary and rotational units. Types of sources used. Basic design and construction – sources, head, gantry, collimator, table. Types of shutter and mechanisms. Control and console. Accessories used. Room layout.

Linear Accelerator: Basic design and construction – modulator, source of RF power, electron gun, accelerating structure head, gantry and collimators (various types including multileaf collimators), flattening filter, scattering foil, dose chambers table. Electron cone and other accessories used.

Brachytherapy equipment: Preloaded, manual afterloading and remove afterloading. Mould, interstitial, intracavitary, intraluminal brachytherapy. Systems of brachytherapy – Manchester, Paris, Quimby. Dose rate in brachytherapy – LDR, HDR and MDR. Types of sources in common use. Various types of applicators used. Common brachytherapy equipment and accessories. Layout of brachytherapy suite (OT, imaging, Planning, Treatment).

Optical Systems, Couches ad laser systems used in radiation oncology.

Treatment planning system : Types of planning systems – 2D, 3D. Basic principle of functioning. Image acquisition for planning.

Basic principles of Conventional X-ray equipments e.g. Simulator, Image intensifiers, Fluoroscopy, DSA ad C-arm, CT Scanners, MRI Scanners, Digital radiography, Beam directional devices. Applicators and diaphragms, etc.

Quality assurance in radiotherapy: Complete quality assurance and quality tests of Simulator, Treatment Planning System, Telegamma Unit, Linear Accelerator, Brachytherapy Equipment, Sealed sources used in brachytherapy

Paper II

Radiographic Techniques

Dark Room: Layout of dark room, size of dak room and types of entrance. Safe lights – types, testing for efficiency and safety. Cleaning of dark room. A brief outline of the formation of the latent image. Purposes of development, fixing and washing. Methods of silver recovery.

X-ray Films: Construction of x-ray film, base material substratum coating, emulsion, anti abrasive supercoating, double coating and the advantage of double coated film (double sided emulsion). Storage of un-exposed film materials, main stock, films in use, records of film stock. Types of emulsion, characteristics & control, screen films and non – screen films.

Film Characteristics: Optical density and broad appreciation of the characteristic curves of x-ray emulsions. Contrast, gamma infinity, exposure latitude, speed, d-max, basic fog. Correct exposure, under and over exposure as related to characteristics curve. Minimum fog value and grain, suitable contrast.

Intensifying screens: Fluorescence, applications of fluorescence to radiography, construction of an intensifying screen, types of intensifying screen. Intensifying factor, relative speeds of intensifying screens, factors affecting the speed of screens, unsharpness relative to the speed of the screens.

Cassette: Types of x-ray cassette for good screen contact and for light leakage. General care of cassettes and screens.

Photographic requirement of fluoroscopy: Fluorescent screen: spectral emission to provide maximum brightness and optimum resolution.

Automatic processing: Basic principles, features of equipment, advantages and limitations of automatic processing systems, maintenance and cleaning of equipments.

3rd Year

Paper I

Radiotherapy Treatment techniques

Basic principles of planning & treatment of superficial and deep seated tumors. (Curative & Palliative), planning using isodose charts including isodose shift techniques for curved surfaces and basics of use of computerized TPS.

Basic Radiotherapy Techniques; SSD & SAD Techniques, Single field, parallel opposed fields, multiple fields. Small beam directed therapy and wedge field techniques, Use of patient immobilization, fixation and alignment devices-different types of patient immobilization devices-POP casts, Perspex casts, Thermoplastic, Vac-lok, Redifoam, preparation and use of various types of immobilization devices, bite blocks, head, arm and leg support and restraining straps, shoulder retractors, laser beams, Testicular shields, breast cone, customized shield making equipment - manual and computerized, electron cone template and shielding, various types of shielding materials – lead and low melting point alloys.

Radiation Therapy Techniques for Specific Sites;

Radiation planning & treatment techniques in head and neck cancer, especially cancers of larynx, maxillary antrum, Nasopharynx, ear, salivary glands, etc.

Planning & Treatment techniques in cancer of breast by telecobalt, low energy mega-voltage, x-rays and electron beam. Use of breast board.

Tele and brachytherapy planning techniques of treatment of different stages of carcinoma uterine cervix with special emphasis on HDR and LDR brachytherapy.

Three field planning and treatment techniques in cancer of esophagus and bladder.

Radiotherapy technique in medulloblastoma and pituitary tumors for planning and treatment.

Planning treatment technique of malignant and non-malignant conditions of eye.

Techniques of planning and treatment in lung and bone tumors.

Large field planning and irradiation techniques in ovarian and kidney tumors.

Radiation planning treatment technique of lymphomas with special emphasis on mantle field irradiation.

Paper II

Recent advances

Special Radiation Therapy Techniques

Whole body and hemi body radiation planning and treatment techniques.

Brachytherapy techniques: Intracavitary, Intraluminal, Interstitial and Mould Therapy

Principle, details, equipments used in

i. 3D-CRT
ii. SRS & SRT
iii. IMRT
iv. IGRT
v. Gated therapy