Module Specification

Applied Radiotherapy Physics and Nuclear Medicine

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Contents

Part 1: Information

Module title: Applied Radiotherapy Physics and Nuclear Medicine

Module code: USSKLP-30-3

Level: Level 6

For implementation from: 2023-24

UWE credit rating: 30

ECTS credit rating: 15

Faculty: Faculty of Health & Applied Sciences

Department: HAS Dept of Applied Sciences

Partner institutions: None

Field: Applied Sciences

Module type: Module

Pre-requisites: None

Excluded combinations: None

Co-requisites: None

Continuing professional development: No

Professional, statutory or regulatory body requirements: None

Part 2: Description

Overview: This module explores advanced topics in radiation physics and nuclear medicine and contains two distinct units, namely:

Unit 1: Cancer, Radiobiology and Clinical Radiotherapy Physics
Unit 2: Clinical Indication, Pathology and Patient Care

Students complete one of these units as prescribed by their pathway. Unit 1 aligns to

the Healthcare Science (Medical Physics) Radiotherapy Physics pathway. Unit 2 aligns to the Healthcare Science (Medical Physics) Nuclear Medicine pathway.

Features: Module Entry requirements: Students must have a level 5 (or equivalent) medical physics qualification

Educational aims: See Learning Outcomes.

Outline syllabus: The syllabus covers:

Cancer, Radiobiology and Clinical Radiotherapy Physics (Radiotherapy Physics pathway):

The overall aim of this unit is to ensure that the student has an understanding of the treatment planning process and the physics that underpins it, and appreciates its place within the clinical context of radiotherapy. All of the below should be considered for photon and charged particle therapy. Intensity-modulated radiotherapy (IMRT) should be considered to include both fixed beam and dynamic arc therapy.

Clinical evaluation including application of medical imaging to radiotherapy:
Referral pathways, including national pathway guidelines
Clinical evaluation: pathology, staging, investigations
Therapy options, including new technologies
Aim of radiotherapy: radical, adjuvant, palliation
Follow-up
Imaging, including the choice and appraisal of different techniques: multiplanar sectional anatomy from CT and MRI, functional imaging; PET and SPECT

Radiobiology related to radiotherapy:
Linear energy transfer and radiobiological effect: Cell survival curves; shape, cell kill, chromosomes and cell division, Dose response relationship, Radiosensitivity, Tumour systems, Dose: time relationship, Radiation pathology: acute and late effects, Radiation carcinogenesis, Radiobiological models: linear quadratic, Biological effective dose

Tumour pathology:
Anatomy, pathology, lymphatic drainage and associated critical structures: head and neck, central nervous system, pituitary, thorax, breast, abdomen, pelvis
Hodgkin's disease
Leukaemia
Extremities
Metastases

Treatment planning considerations:
Prescribed dose
Target delineation
Treatment techniques (site specific)
Typical tissue heterogeneities
Beam weighting
Guidelines for field arrangement
Field matching
Energy

Positioning and immobilisation:
Back pointers
Patient positioning equipment
Patient care in the mould room
Immobilisation (site specific)
Motion management, for example, deep inspiration breath hold (DIBH), gating
Dosimetric effects of equipment

Localisation:
CT localisation: inhomogeneities, surface contours and organs at risk
Use of other imaging and image fusion (MRI, PET-CT)
Data transfer

Dose planning and display:
Treatment planning algorithms, including pencil beam, collapsed cone and Monte Carlo

International Commission on Radiological Units and Measurements (ICRU) recommendations
Planning target volume: margins
Computer planning: 3-dimensional and 4-dimensional plans, beam's eye view
Plan evaluation: isodose distributions, dose volume histograms
Conformal planning
Optimisation, including inverse planning techniques and IMRT
Forward planned segmented field techniques

Beam modification:
Collimation – beam matching
Beam shaping and shielding
Bolus and compensators
Wedges: mechanical, dynamic, virtual

Dose calculations:
Dose distribution computation
Organs at risk (critical organs and dose constraints)
Dose prescription
Phantom scatter factors: back scatter factor, peak scatter factor
Head scatter
Radiation output
Computation of treatment time/set dose
Effect of inhomogeneities

Verification:
Positional accuracy and tolerances
Dosimetric accuracy: patient dose monitoring
Record and verify systems
Image guided radiotherapy (IGRT)
Adaptive radiotherapy

Brachytherapy preparation and planning for temporary and permanent implants:
Key clinical applications

Guidance and recommendations
Sources: nuclide, structure, identification
After-loading equipment
Calculation algorithms
Units of measurement
Source calibration
Calculation of dose distributions

Clinical Indication, Pathology and Patient Care (Nuclear Medicine pathway):

The overall aim of this unit is to ensure that the student has the underpinning knowledge to allow them to carry out a range of nuclear medicine investigations. All of the content in this unit should consider both adult and paediatric applications.

Review, with reference to the planning and interpretation of radionuclide tests and therapy: anatomy and physiology, immunology, infection (acute, chronic, pus, abscess, differential diagnosis between abscess, cyst and tumour), neoplastic disease (tumours, primary and secondary (metastases), benign and malignant tumours, assessing the extent of malignant involvement)

Review of radiobiological effects of ionising radiation

Radiopharmaceuticals used in nuclear medicine: the design and operation of the radiopharmacy, Good Manufacturing Practice, the types of preparation, sterilisation techniques, maintaining and monitoring the pharmaceutical environment, waste disposal

Radiochemistry and QC: the chemistry of commonly used radionuclides, radiochemical techniques, production of radiopharmaceuticals, labelling of blood products, selection of appropriate radiopharmaceutical

Techniques requiring the assay of radioactive samples in vitro non-imaging

The clinical application of nuclear medicine

Assessment of appropriateness of commonly requested tests or procedures, for all the body systems listed below, which should include an understanding of:

The radiopharmaceutical used, activity administered and route of administration, half-life, energy

The preparation of the patient

The views and samples that must be obtained, dynamic protocols, static protocols, SPECT, SPECT-CT, PET-CT, PETMR: the use of any special data handling techniques or display mode, any special features of the study, possible artefacts, setting up the equipment: energy windows, collimation, the clinical context in which radionuclide tests may be of value and the influence of the test results on patient management, the radiation dose to the patient and the risks and benefits of the particular radionuclide test to a particular patient, new developments in nuclear medicine, and the changing role of nuclear medicine in the diagnosis and treatment of disease and the relevant imaging modalities used in reaching a diagnosis

All the above should be applied to the following body systems: Skeletal system, Central nervous system, Endocrine system, Cardiovascular system, Respiratory system, Urinary system, Gastrointestinal system, Hemopoietic and lymphatic system, Reproductive system, Oncological applications, Infection and inflammatory imaging

Therapeutic applications of radionuclides in nuclear medicine:
Dosimetry in molecular radiotherapy
Radionuclide therapy in thyroid carcinoma
Radionuclide therapy in benign thyroid disease
Radionuclide therapy in neuroendocrine tumours
Radionuclide therapy in hepatocellular carcinoma
Radioimmunotherapy in lymphoma and other blood disorders
Radionuclide therapy of refractory metastatic bone pain
Radiosynovectomy

Future developments in therapeutic nuclear medicine applications
Nursing implications for patients undergoing radionuclide metabolic therapy

Part 3: Teaching and learning methods

Teaching and learning methods: There will be 3 weeks of contact time at UWE in 3 x 1 week blocks. Included in each block week are laboratory workshops, lectures and tutorials. The contact time will equate to approximately 12 hours per block (a total of 36 hours).

In addition to the allocated hours on campus learning, students will engage in synchronous and asynchronous online learning. This will comprise a total of approximately 36 hours of online engagement through a combination of lectures, synchronous online tutorials, synchronous and asynchronous discussions, online quizzes, and collaborative group work.

Theoretical material within the module will be presented to the students in the form of regular lectures throughout each of the semesters in the academic year. During those times of work based learning, these lectures will be delivered online and involve a number of technological enhancements. The learning of lecture content will be reinforced through time spent in independent learning by the directed reading of recommended texts and through the use of technology enhanced learning resources that will be provided online. This online learning and engagement will be delivered through several avenues:

Synchronous online tutorials in protected learning time where the student will contribute/attend an online activity appropriate to the content at the time at which the academic will be present online to facilitate and lead this scheduled/timetabled session. These tutorials will be themed/planned.

Asynchronous discussions in the student's own time (or during protected time where permitted and appropriate) where they will engage/collaborate with other students on the course or in specified groups, and in which the academic is permitted to

moderate where necessary, but is not expected to contribute.

Synchronous surgery sessions timetabled for a specific time in which the academic will be available online to answer live questions via discussion boards/blogs/collaborate or to respond to questions posted/asked prior to the session.

Interactive, online formative quizzes made available either following a particular package of knowledge exchange/learning, or in specified sessions/time periods.

Lectures delivered online through a combination of one or more of the following: visual/audio/interactivity/personal formative assessment.

A number of relevant practical sessions will be incorporated during the campus based blocks in addition to the work based learning that must be achieved under supervision by a workplace supervisor. Practical sessions will both drive hands on learning and the acquisition of technical skills at both an individual and group working level.

The remainder of the independent learning time allocated to the module should be spent preparing for assessments (B1), and undertaking revision for the exams (A1, A2).

Scheduled learning includes lectures, seminars, tutorials, project supervision, demonstration, practical classes and workshops; fieldwork; external visits; work based learning; supervised time in studio/workshop.

Independent learning includes hours engaged with essential reading, case study preparation, assignment preparation and completion. These sessions constitute an average time per level. Scheduled sessions may vary slightly depending on the module choices you make.

Module Learning outcomes: On successful completion of this module students will achieve the following learning outcomes.

MO1 Cancer, Radiobiology and Clinical Radiotherapy Physics (Radiotherapy Physics pathway): Critically evaluate the role of radiotherapy in the cancer pathway and critically review tumour pathology of some common tumour sites

MO2 Cancer, Radiobiology and Clinical Radiotherapy Physics (Radiotherapy Physics pathway): Describe and critically evaluate the principles of radiobiology applied to external beam radiotherapy

MO3 Cancer, Radiobiology and Clinical Radiotherapy Physics (Radiotherapy Physics pathway): Compare and contrast the range of treatment planning techniques available, and critically appraise the choice of physical parameters required when preparing treatment plans

MO4 Cancer, Radiobiology and Clinical Radiotherapy Physics (Radiotherapy Physics pathway): Discuss the requirements relating to patient care in the mould room and specify and appraise factors, principles and constraints that affect treatment regimens and treatment planning

MO5 Cancer, Radiobiology and Clinical Radiotherapy Physics (Radiotherapy Physics pathway): Explain target volumes as defined in current national and international standards

MO6 Cancer, Radiobiology and Clinical Radiotherapy Physics (Radiotherapy Physics pathway): Define dose prescriptions and reporting as per current national and international standards

MO7 Clinical Indication, Pathology and Patient Care (Nuclear Medicine pathway): Explain the anatomy and physiology relating to the practice of nuclear medicine

MO8 Clinical Indication, Pathology and Patient Care (Nuclear Medicine pathway): Critically discuss the problems associated with the care of patients undergoing nuclear medicine investigations or treatments

MO9 Clinical Indication, Pathology and Patient Care (Nuclear Medicine pathway): Explain and critically evaluate the procedures, radiation protection and legislative issues surrounding the administration of radioactive materials with adult and paediatric patients

MO10 Clinical Indication, Pathology and Patient Care (Nuclear Medicine pathway): Appraise a range of radiopharmacy techniques, including generators, isotope properties and blood labelling techniques

MO11 Clinical Indication, Pathology and Patient Care (Nuclear Medicine pathway): Describe and critically analyse the role of nuclear medicine in the diagnosis of disease, with reference to a range of different body systems

MO12 Clinical Indication, Pathology and Patient Care (Nuclear Medicine pathway): Discuss and evaluate radiopharmaceuticals in terms of radionuclide chemistry, biological behaviour and factors affecting product quality

MO13 Clinical Indication, Pathology and Patient Care (Nuclear Medicine pathway): Critically review and evaluate applications of nuclear medicine in terms of diagnosis and therapy for a range of body systems with due reference to patient care needs

Hours to be allocated: 300

Contact hours:

Independent study/self-guided study = 228 hours

Face-to-face learning = 72 hours

Total = 300

Reading list: The reading list for this module can be accessed at readinglists.uwe.ac.uk via the following link https://uwe.rl.talis.com/modules/ussklp-30-3.html

Part 4: Assessment

Assessment strategy: Assessment 1: Case Study
Assessment 1 will provide an opportunity for apprentices to demonstrate their ability to apply the principles of their relevant area of medical physics to an unseen problem and/or case study and evidence their skills in approaching and interpreting it appropriately.

Assessment 2: Set Exercise
The set exercise will provide apprentices with an opportunity to demonstrate their knowledge on a broad range of topics and
will assess the apprentices' ability to research relevant information and provide critical thinking in a variety of workplace scenarios where the application of knowledge is required.

Formative feedback is available to students throughout the module through group discussions, and in workshops. Apprentices are provided with formative feed-forward for their set exercise through a revision and preparation session.

Assessment tasks:

Case Study (First Sit)
Description: Case study integrated assignment (1500 words)
Weighting: 50 %
Final assessment: No
Group work: No
Learning outcomes tested: MO1, MO13, MO3, MO8

Set Exercise (First Sit)
Description: Set Exercise
Weighting: 50 %
Final assessment: Yes
Group work: No
Learning outcomes tested: MO10, MO11, MO12, MO13, MO2, MO4, MO5, MO6, MO7, MO9

Case Study (Resit)
Description: Case study integrated assignment (1500 words)
Weighting: 50 %
Final assessment: No
Group work: No
Learning outcomes tested: MO1, MO13, MO3, MO8

Set Exercise (Resit)
Description: Set Exercise
Weighting: 50 %
Final assessment: Yes
Group work: No
Learning outcomes tested: MO10, MO11, MO12, MO13, MO2, MO4, MO5, MO6, MO7, MO9

Part 5: Contributes towards

This module contributes towards the following programmes of study:

Healthcare Science (Nuclear Medicine) {Apprenticeship-UWE} [Sep][FT][Frenchay][3yrs] BSc (Hons) 2021-22

Healthcare Science (Radiotherapy Physics) {Apprenticeship-UWE} [Sep][FT][Frenchay][3yrs] BSc (Hons) 2021-22