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Recommended ESTRO Core Curriculum for RTTs (Radiation Therapists) – 3rd edition

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Table of Contents:

1 Introduction

- 1.1 A European core curriculum
- 1.2 Background
- 1.3 The process of the third revision

2 Professional Identity

- 2.1 Title

3 Educational Infrastructure and organisation

- 3.1 Learning environment
- 3.2 Programme leader
- 3.3 Academic staff
- 3.4 Academic environment
- 3.5 Clinical environment
- 3.6 Clinical educators
- 3.7 Course duration
- 3.8 European Credit Transfer and Accumulation System (ECTs)
- 3.9 Audit of the education programme
- 3.10 Certification

ESTRO

4 Competences

4.1 *Clinical competences*

- 4.1.1 Professionalism
- 4.1.2 Positioning and immobilisation
- 4.1.3 Image acquisition and virtual simulation
- 4.1.4 Treatment planning
- 4.1.5 On treatment verification
- 4.1.6 External beam treatment delivery
- 4.1.7 Quality Assurance
- 4.1.8 Brachytherapy
- 4.1.9 Research
- 4.1.10 Education

5 Curriculum topics

5.1 *General Academic Competency content*

- 5.1.1 Biology
- 5.1.2 Chemistry
- 5.1.3 Physics (including basic mathematical concepts)
- 5.1.4 Biochemistry
- 5.1.5 Anatomy
- 5.1.6 Physiology
- 5.1.7 Psychology
- 5.1.8 Information Technology

5.2 *Radiation Specific Competency*

- 5.2.1 Radiation Physics
- 5.2.2 Principles of Oncology
- 5.2.3 Cancer Prevention and Early Detection
- 5.2.4 Cancer Diagnosis
- 5.2.5 Treatment Decisions and Modalities
- 5.2.6 *External Beam Radiotherapy*
 - 5.2.6.1 Patient Positioning and Immobilisation
 - 5.2.6.2 Internal Organ Motion Control
- 5.2.7 Image Acquisition for Planning Purposes

ESTRO

5.2.8 Treatment Planning

5.2.9 Radiotherapy Delivery and Image Acquisition for Treatment
Verification

5.2.10 Patient Care and Support

5.2.11 Quality Assurance and Risk Management

5.1.12 Management

5.1.13 Research Methodology and Statistics

6 Teaching Methods

6.1 Lecture

6.2 Laboratory based

6.3 Clinical topics

6.4 Tutorials

6.5 Journal Club

6.6 Case studies

6.7 Problem based learning

6.8 E-Learning

7 Assessment

7.1 *Methods of assessment*

7.1.1 Traditional examination

7.1.2 Open book examination

7.1.3 Types of questions used

7.1.4 Multiple Choice Examinations

7.1.5 Portfolio

7.1.6 Reflective Diaries

7.1.7 Viva Voce or Oral examinations

7.1.8 Objective Structure Clinical Examination (OSCE)

7.1.9 Presentations

7.1.10 Posters

References

Bibliography

ESTRO

1.0 INTRODUCTION

1.1 A European core curriculum

A European core curriculum is necessary to set standards which are recognisable across all member states. A core curriculum should be used to facilitate the development of local or national programmes where these do not already exist, and to improve, revise or expand existing curricula based on identified essential topics and core competences. This core curriculum is for use by instructors in radiotherapy who can select the topics most relevant for the RTTs at any given time and at a level appropriate for their programme. RTTs are the group of professionals with direct responsibility for the administration of radiotherapy to cancer patients, their roles and responsibilities currently vary considerably both between and within countries.

When a standard approach to radiation therapy education is achieved across the member states the European Union aspiration of freedom of movement for all persons will be more readily achievable. Employability and mobility are also identified as priorities in higher education for the coming decade [1]. Currently the wide variation in education content and standard, scope of practice and level of responsibility expected limit freedom of movement and employability of RTTs across Europe.

The approach taken as part of this third revision was to gain information on the existing education programmes and to identify the current scope of practice and level of responsibility taken by RTTs through a Europe wide survey [Appendix 1]. The results of the survey showed that although there was some disparity in the clinical practice of RTTs across the 28 countries, the core activities were reasonably consistent. However there was a wide variation in the education background and the level of responsibility taken by individual RTTs and their involvement in different areas within the radiotherapy department. The results of the survey have been used to define the core competences for this curriculum.

The findings of the survey indicated very limited academic content or clinical education directly relevant to the practice of radiation therapy. Linking the findings of the survey with the associated knowledge level and skills required should improve the quality of the radiotherapy

ESTRO

education programmes improving the quality of treatment provided to cancer patients receiving radiotherapy and facilitate progress towards the aspiration of free movement.

1.2 Background

The European Society for Therapeutic Radiology and Oncology (ESTRO) is a multidisciplinary society of individual radiation oncologists, radiotherapy physicists, radiobiologist and RTTs. ESTRO has developed a remit for improving standards and practice, for providing radiotherapy specific education and for fostering research and development in radiotherapy both in Europe and internationally. It has taken the lead in developing and delivering guidance frameworks in education and quality assurance in radiotherapy and has produced consensus documents which have been endorsed by a wide range of national societies. ESTRO is the first European association to provide a unique forum for RTTs in a radiotherapy environment.

ESTRO supported the development of the first core curriculum for RTTs in 1995 and the second revision in 2004 [2]. The first curriculum focussed on academic content and curriculum philosophy and the second revision contained detailed information on establishing education programmes, clinical and technological developments in radiotherapy and the evolving role of the RTT. Both curricula were used by educationalist as part of their course development or restructuring.

Health education has evolved in the interim period and is now commonly based on core competences defined through learning outcomes. This third revision is based on this model and the structure is consistent with the ESTRO revised guidelines for education and training for the radiation oncologists and medical physicists. Competency based training in other jurisdictions has been consulted and incorporated where appropriate.

The revised curriculum will reflect changing practice and professional status for RTTs and will be based on the competences required to practice as an RTT. This is consistent with the findings of the survey and with other educational philosophies such as those described by the European Qualification Framework for Life Long Learning where competence is defined as:

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'The proven ability to use knowledge, skills and personal, social and/or methodological abilities in work or study situations and in professional and personal development' [3]

and in the Canadian CANMEDS system for medical education [4] and the radiation therapy competency profile prepared by the Radiation Therapy Competency Profile Task Group of the Canadian Association of Medical Radiation Technologists (CAMRT) [5] (Revised Feb 2008) who state in their introduction:

"The profile defines competences reflecting the integration of knowledge, skills and attitudes and judgement necessary to practice in an environment that required the therapist to use effective organisational skills and critical thinking. This requires the ability to assess adapt, modify, analyse and evaluate in a variety of settings and environments in the practice of radiation therapy".

Graduates of a course designed from this core curriculum will achieve the competences as outlined above. They will be able to work as autonomous professionals within the context of a multidisciplinary approach to treatment preparation and delivery and patient care. Given the level of responsibility undertaken by RTTs in the performance of their role it is important that their education standard is such that it allows for a level of professional autonomy within the context of a multidisciplinary approach to patient management. Autonomy, in this context, refers to taking personal responsibility for her/his role in the accurate preparation and administration of a course of radiation therapy and the subsequent monitoring of the patient while they are attending the treatment unit.

They will be in a better position to influence high quality practice in their own departments and also in their own countries.

Given the complexity of modern radiotherapy, education programmes for RTTs should be specific to that profession. The education programme should provide the RTT with the scientific basis of the profession and enable them, as graduates, to be able to synthesise, evaluate and apply their knowledge in a clinical setting. On graduation the RTT should have reached the level

ESTRO

of competency to practice as an autonomous professional and effective member of the radiotherapy team.

1.3 The process of the third revision

The process of the third revision was based on circulation of a questionnaire which formed the basis of the survey on RTT practice. This questionnaire was developed by a working group comprising RTTs working in both the clinical and academic setting and the topics included:

- academic and clinical education
- infrastructure, resources and delivery of the education programme
- the professional status of RTs nationally
- the scope of practice and responsibility taken by RTTs at the time of their graduation and subsequently during their career.

Scope of practice included all aspects of treatment preparation and delivery, support and care, quality assurance, research and management. The questionnaire was sent to the national societies of 42 countries with a final response from 28 countries giving a comprehensive overview of education programmes and scope of practice of RTTs across Europe.

Reflecting the findings of the survey on scope of practice and levels of responsibility and consistent with the educational philosophies defined earlier and the ESTRO approach to the radiation oncologist and medical physics curricula; the third revision of the core curriculum for RTTs will focus on competences linked with learning outcomes and the essential knowledge and skills underpinning practice.

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2.0 Professional identity

Radiotherapy uses ionising radiation either alone or in combination with other treatment modalities for the treatment of patients primarily with malignant disease. RTTs are the group of professionals with direct responsibility for the administration of radiotherapy to cancer patients. This encompasses the safe and accurate delivery of the radiation dose prescribed and the clinical care and support of the patient on a daily basis throughout the treatment preparation, treatment and immediate post treatment phases. The RTT is often the link person for the patient within the multidisciplinary team comprising essentially the radiation oncologist, radiotherapy medical physicist and the RTT. RTTs liaise with all the other associated professionals in ensuring the needs of the patient are met.

The ICRP, in report 48 of 2000, acknowledges this role where it states 'Radiation therapy technologists have the responsibility for the set-up and delivery of the treatment, are involved in the simulation of the treatment, and have, therefore, an essential function in noticing any abnormal reaction of the patient or the machine and to report them'[6].

2.1 Title

The lack of a single title creates difficulties in terms of identity and also the free movement of personnel that is integral to the development of the European Community and a clearly identified aspiration. All recognised professions have an internationally accepted title that defines, within national limits, their role. This has not been the case for the professionals directly involved in the delivery of radiation therapy to patients. Currently many different titles are used throughout Europe to describe the members of our profession. The survey carried out identified 22 different titles (Appendix 2).

As part of the previous revision consensus was achieved on the title of Radiation Therapist (RT) [2]. This title is consistent with that used in many countries worldwide to describe the professional group. It has been agreed by ESTRO that RTT can encompass the title Radiation Therapist with the following conditions:

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- The title RTT will be maintained by ESTRO but will now encompass “Radiation Therapist” and this fits also with the previous denomination of “radiation technologist”
- ESTRO states that Radiation Therapist as a RTT title should be used only when it does not conflict with the title used for clinicians in said country

The acceptance of this title, under the umbrella of RTT, is also being considered by the International Atomic Energy Agency (IAEA). In the period since the second revision several countries have adopted the title radiation therapist or are in the process of negotiating this change.

3.0 Educational infrastructure and organisation

The programme should be sited in a University or Higher Education Institute and preferably within a health related faculty. There are two components to an initial / undergraduate education programme for RTTs, the academic and clinical components where the learning outcomes of each should be complementary.

Postgraduate programmes and continuing professional education and development courses are also necessary to ensure maintenance of knowledge and skills in an ever changing environment and generally also require linkage of an academic and clinical component. Seven of the respondents indicated that a postgraduate programme was already in place in their country, three countries were in the process of implementing a programme and in two countries there was no formal postgraduate programme but a process of continuing professional development (CPD) or continuing medical education (CME) was required for continuing registration. Fifteen countries responded that CPD or CME was available to RTs in their country. This complementarity requires close collaboration with the education institute and the clinical departments to ensure that RTs graduating from such a programme are competent to practice in a range of clinical settings. Ideally teaching agreements should be in place between the educational institutes and clinical departments to ensure ongoing commitment to RTT education. The survey showed that teaching agreements were in place in twenty six responding countries. Essential aspects of the educational infrastructure and organisation are considered in the following sections.

ESTRO

3.1 The learning environment

The learning environment must be adequate to enable the delivery of the programme. This includes the academic and clinical environment, physical resources and staff. Where a single institution cannot provide the necessary infrastructure a programme could be shared between two or more institutions. Where the radiotherapy education is part of a non radiotherapy programme eg. nursing or diagnostic radiography, adequate resources must be allocated to the radiotherapy component in order to achieve the standard required.

Very close liaison and/or partnerships must be established between the academic and clinical environment with regular meetings to monitor student progress and exchange of knowledge and information on the changes taking place in each environment.

3.2 Programme leader

In each institution a programme / course leader must be appointed. This programme leader must have the appropriate level of authority and autonomy to take decisions that directly affect the programme. The programme director is responsible for the general administration, resources, structure and content of the programme. The programme director ensures that the programme fulfils the criteria for competency as outlined in this core curriculum and also the national requirements. S/he will be responsible for ensuring that the criteria for the programme are implemented, the outcomes achieved, national or professional requirements are met and ongoing development to meet clinical changes are integrated and that regular audit of quality takes place. Where the University or Higher Education Institute academic requirements cannot be immediately met by a radiation therapy professional, accommodation must be made to enable an experienced senior level RTT to be appointed to oversee the programme with provision made for him/her to work towards a higher level academic qualification.

From our survey it is clear that there are only a small number of programmes where an RTT has been appointed as the radiotherapy programme leader. Frequently the radiation oncologists are responsible for the programme and in many instances the programme leader is from a non radiotherapy background. In some institutes advice is sought from the senior clinical staff regarding the curriculum content but this frequently relates only to clinical aspects.

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3.3 Academic staff

The academic staff should meet the national or institutional requirement for RTT/staff ratio, and should reflect the significant clinical or practical component of the programme. Dedicated staff must be able to deliver the academic components of the curriculum and are responsible for maintaining their own knowledge and understanding of developments in oncology generally and radiation therapy specifically and on educational philosophy and developments. This should include attendance at national and international conferences and workshops where lecturers from other related disciplines should be invited to participate when necessary. The institution must make facilities and resources available to academic staff to reach the required academic standard of the institution.

Regular staff meetings should be held to review the aims and learning outcomes of the programme, its effectiveness, educational validity and future developments.

3.4 Academic environment

Teaching areas that are fit for purpose and meet the health and safety standards are essential. A sufficient variety of relevant textbooks, reference books and current journals pertinent to oncology and radiation therapy must be available to the RTTs. Adequate access to computer facilities in terms of hardware and software must be provided. This should include internet access and computerised databases for educational and research purposes. Access to IT facilities to support both skills training and an understanding of the complexities of radiotherapy i.e. a dedicated treatment planning system, immobilisation devices, image matching software are desirable to facilitate RTT learning outside of the clinical environment.

3.5 Clinical environment

Students must be exposed to the widest possible clinical experience. This may necessitate using several clinical departments. As a core requirement students must spend a significant amount of time on dual modality multi energy linear accelerators with imaging facilities and CT scanners/simulators for treatment planning purposes. It is also recommended that students

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have exposure to orthovoltage/superficial units, brachytherapy and advanced technologies. Treatment planning to underpin understanding is integral to radiation therapy education. If treatment planning facilities are not available in the academic environment the student should be able to spend time in treatment planning in the clinical setting. Where other diagnostic modalities are used as part of the treatment planning process students should also have the opportunity to spend time in these areas. Students should also be placed in the support areas within the department and should attend the multidisciplinary meetings where these are in place.

Formal teaching agreements should be in place between the academic institute and all clinical departments where students are placed. Our survey showed that most respondents have teaching agreements, either formal or informal, between the academic institutes and the clinical departments.

3.6 Clinical educators

A member of the academic faculty must be designated as the clinical coordinator with responsibility for the oversight of the clinical education programme. S/he will liaise with all affiliated clinical departments to ensure equity of experience for all students. Clinical tutors should be present in each department. They will ensure that students make the transfer from theory to practice in a structured setting and take an active role in curriculum development and review, arranging placements and assessing students in collaboration with the clinical coordinator and other members of the academic staff. Where a clinical tutor is not achievable identified clinical staff in each department should take responsibility for ensuring active learning takes place and be responsible for co-ordinating the student placement by assigning students to named clinical RTTs.

Time and support must be given to the clinical educators and they should be actively involved in the design of the clinical education programme. They should be affiliated to the academic institute and receive training in clinical teaching and assessment. However to help to ensure that the standard of clinical education is optimum it is important that all RTTs within the clinical department are directly involved in the delivery of the clinical education programme.

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Our survey showed that the majority of programmes have designated clinical staff for student education with 12 centres having an affiliation with the education institute. However a system of clinical assessment is in place in only 6 institutions.

3.7 Course duration

It is recommended that any programme developed from this core curriculum should be of a minimum of three years duration. The IAEA have also endorsed the concept of a dedicated two year programme for RTTs [7] and in their current curriculum revision are considering advising progression towards a dedicated three year education programme where possible. In all programmes, including joint programmes, a minimum of 20% and ideally 25-30% of the overall course duration should be devoted to radiotherapy clinical education. This should be on a continuum of change from theory to practice over the programme to allow for the student to develop their critical thinking skills and the application of theoretical knowledge in the clinical setting. The emphasis on the first year should be on the academic content and establishment of a strong scientific basis and in the latter years on the application of theory to clinical/reflective practice and the development of research skills. In this way the student should progress from a position of dependency to one of increasing autonomy in the clinical environment.

Our survey showed that 20 of the 28 programmes are of 3-4 years duration with 4 programmes of 2 year duration. Only 4 programmes were dedicated to radiotherapy. The non-radiotherapy specific courses are predominantly diagnostic radiography with two countries having a significant radiotherapy component but the majority having minimal or no radiotherapy content. In four of the respondent countries the basic education programme is nursing with three having a requirement for postgraduate education in radiotherapy.

3.8 European Credit Transfer and Accumulation System (ECTS)

To facilitate a more standardised and transparent approach to programme evaluation and qualification recognition it has been agreed that the ECTS should be used wherever possible.

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The ECTS is considered as one of the cornerstones of the European Higher Education Area and the Bologna Process [8]. ECTS have a fundamental place in the design of national and European Qualifications Framework. They can be applied to all programmes at all levels and should enable ease of comparison.

ECTS are student centred and reflect the level of work that is required by a typical student to achieve the learning outcomes and competences defined by the programme. They are based on the principle that 60 credits is a measure of the workload that a full time student would realistically be expected to carry out during one academic year. In most instances this ranges between 1500 – 1800 hours or 20-30 hours per credit. ECTS include all student related effort and incorporate both face to face contact and a reflection of the level of independent preparation or study required for each specific component of the programme. The basis of the estimation of workload and the ECTS allocation is the learning outcome and competence associated with the course. The definition of learning outcomes is therefore core as a reflection of what the learner will know, understand and be able to do at the end of a learning experience.

3.9 Audit of the education programme

The education programme should be subject to continuous internal and regular external academic and clinical audit to ensure that the academic and clinical education standard is maintained at the appropriate level and the course is consistent with the requirements for clinical practice. There should be periodic review of all associated clinical centres and audit of outcomes to ensure standards are maintained or improved.

3.10 Certification

Certification level remains varied across Europe. Certification level should be degree if the graduate is expected to practice as outlined previously. This is consistent with the situation in countries where the education programme for RTTs is well established and with the ICRP 86 report which recommends that: 'radiation therapy technologists, dosimetrists, and nurses,

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should have a degree, granted by a university or medical school, in academic studies and clinical training for a period of three or four years' [6]. The IAEA are reviewing their curriculum and as part of this process considering the requirement of degree level education for RTTs.

Certification of qualifications should, as far as possible, be within the framework of the Bologna process. As part of the Bologna process a Framework of Qualification for the European Higher Education Area has been developed. This is effectively an overarching framework of qualifications aiming to provide international transparency, recognition and mobility [9]. This framework stipulates the outline and boundary of national frameworks that can reflect national educational differences. It augments national frameworks by providing a series of reference points whereby mutual compatibility can be demonstrated. It does not prescribe content. A system has been adopted based on three cycles at higher level education where learning achievement can be described and related in a coherent way. A national framework provides a context for the review, articulation and development of existing qualifications and provides a context for the design of new qualifications consistent with the aims of this core curriculum. National frameworks are also in place internationally for instance in Australia, New Zealand and South Africa where an outcomes based approach has been increasingly adopted. [10, 11, 12]

Furthermore a framework can act to bring about change and can be used to indicate where new programmes are required to meet societal needs including the introduction of new qualifications [9].

Qualifications are defined as

“any degree, diploma or other certificate issued by a competent authority attesting that particular learning outcomes have been achieved, normally following the successful completion of a recognised higher education programme of study” [9].

The Dublin Descriptors have been developed and adopted by the Bologna process to describe the levels in higher education. They offer “generic statements of typical expectations of achievement and abilities associated with qualifications that represent the end of each Bologna cycle” and are built on knowledge and understanding, applying knowledge and understanding, making judgments, communication skills and learning skills [9].

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These descriptors are appropriate in the context of this core curriculum and can be used to describe outcomes at the end of a first cycle of study that can be further developed and built upon. This gives the flexibility for institutions expanding an existing programme to add components in a structured and certifiable way. The two level descriptors that are relevant to this core curriculum are at the level one cycle. This cycle is subdivided to allow a short cycle to be included and the two cycles are defined in terms of their qualification as follows:

Qualifications (short cycle in cycle 1, 120 credits)

“builds on general secondary education typically at a level supported by advanced textbooks: such knowledge provides an underpinning for a field of work or vocation, personal development and further studies to complete the 1st cycle

- Can apply knowledge and understanding in occupational contexts
- Have the ability to identify and use data to formulate responses to well defined concrete and abstract problems
- Can communicate about their understanding, skills and activities with peers, supervisors and clients
- Have the learning skills to undertake further studies with some autonomy”

Qualifications signifying completion of the first cycle (180-240 credits)

“builds on general secondary education typically at a level supported by advanced textbooks: includes some aspect that will be informed by knowledge of the forefront of their field of study

- Can apply their knowledge and understanding in a manner that indicates a professional approach to their work or vocation and have competences typically demonstrated through devising and sustaining arguments and solving problems within their field of study
- Have the ability to gather and interpret relevant data (usually within their field of study) to inform judgements that include reflection on relevant, social, scientific or ethical issues
- Can communicate information, ideas, problems and solutions to both specialist and non-specialist audiences

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- Have developed those learning skills that are necessary for them to continue to undertake further study with a high degree of autonomy"[9]

Using these descriptors allows institutions to both prepare programmes designed to meet the occupational requirements and also to meet the professional and discipline needs of a research basis for practice and future development within a recognised international structure.

Our survey showed that the qualification in 12 countries is at degree level, 12 at diploma level, 1 at certificate level and three are postgraduate following a short cycle or first cycle programme in either diagnostic imaging or nursing. From the framework for qualification used in this core curriculum we have taken the diploma level to be the short cycle of the first level. The progression through the levels is generally certificate to diploma to degree. Four of the primary qualifications are in radiation therapy and of the 24 courses, 2 are combined courses have a significant radiotherapy component, 4 primary qualifications are in nursing and 18 are combined with a non-radiotherapy area with a minority radiotherapy component.

4.0 Competences

A competence shows a capability on the part of an RTT and demonstrates an ability to integrate knowledge, skills and attitudes to meet specific and often complex needs in a range of situations. The core curriculum defines the competences a new qualified RTT should have attained. These competences will enable the new graduate to work independently following a short period of orientation to familiarise them with the practices within the department.

From the survey only 30% of graduates are expected to work independently on appointment. It is assumed that this is a reflection of the minimal radiotherapy content of the primary education programmes. The mentorship period ranged from 2 weeks to 3 years and was mainly supervision by the senior RTTs on the treatment units. With the exception of treatment planning and brachytherapy, 60% of RTTs are expected to be able to work in all areas of the department with 30% also expected to be competent to work in simulation / treatment preparation.

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RTTs make a unique contribution to the excellence of the radiotherapy process and are dedicated to the health and welfare of their patients. Their work requires the mastery of a complex body of knowledge and skills and the application of these in the holistic care of their patients. Their professional role is guided by defined codes of ethics and standards, a commitment to excellence in the delivery of treatment to their patients and to work with integrity and compassion at all times. RTTs must be able to communicate and collaborate with a wide range of people and as frontline health professionals they also have a responsibility to participate in improving the overall health of society. They must effectively organise and manage their daily practice even as a new graduate.

Certain competences have elements that are generic to a wide range of healthcare disciplines where others are RTT specific. In defining the competences for the survey and the core curriculum the patient pathway through the radiotherapy process has been followed. The definitions of competence and learning outcomes from the Tuning Project in differentiating between them in this core curriculum will be used [13]: “a competence is a quality, ability, capacity or skill that is developed by and belongs to the student. A Learning Outcome is a measurable result of a learning experience which allows us to ascertain to which extent/level/standard a competence has been formed or enhanced.”

The competences defined in the following section can be measured through a series of learning outcomes and linked by the faculty to teaching and assessment methods that are appropriate and achievable in their institution.

The competences have been described using Bloom's taxonomy or classification. In 1956 Benjamin Bloom [14] devised his taxonomy to classify forms and levels of learning. It was based on the premise that you cannot apply or evaluate something until you understand it, learning at the higher level is dependent on having acquired the prerequisite knowledge and skills at lower levels. In 2001 it was revised by Anderson and Krathwohl to reflect more current approaches to teaching and learning but the basic premise remains the same. [15]

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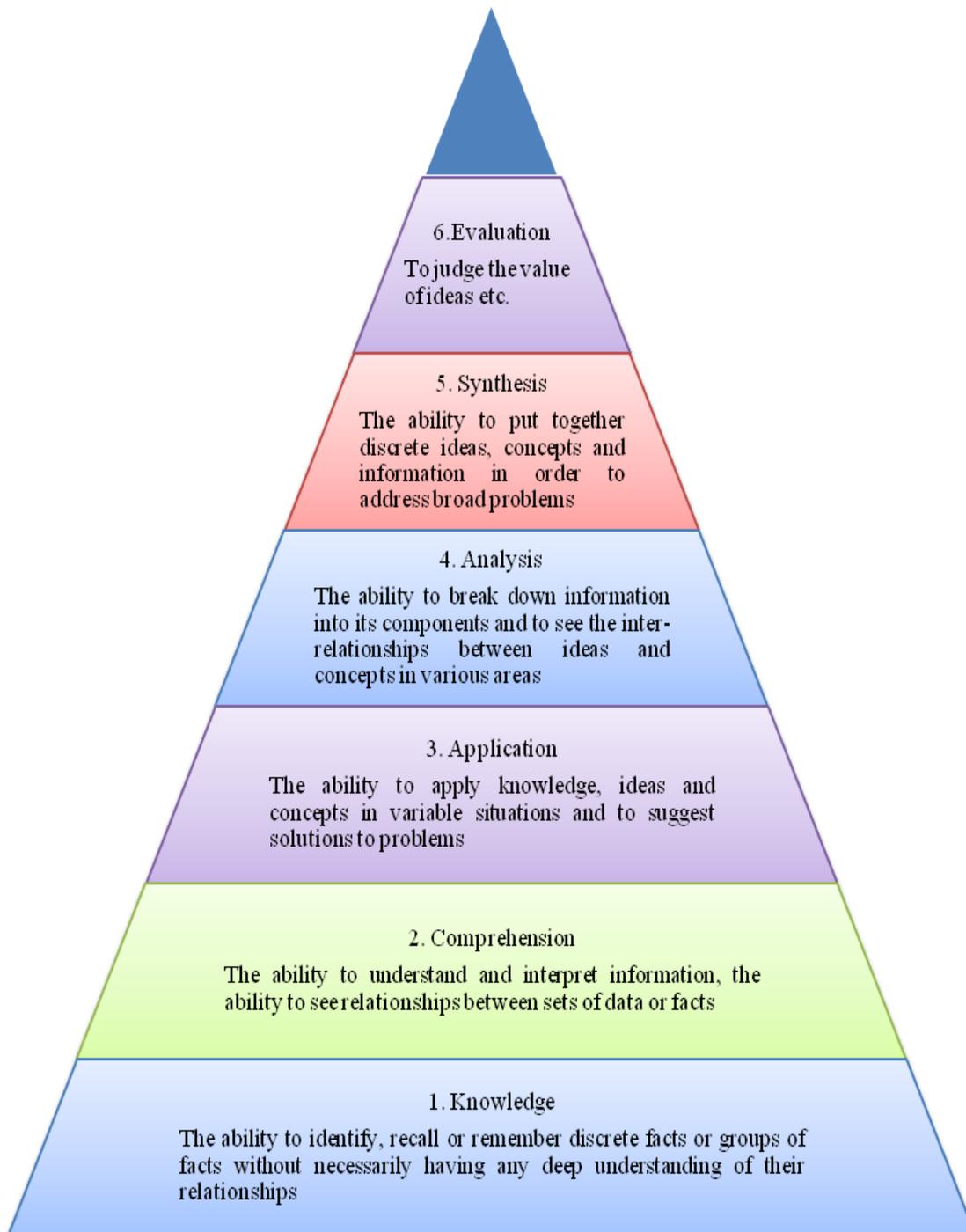


Figure 1:
Bloom's

Taxonomy

In the curriculum we have distinguished the competences directly reflecting daily clinical practice including the general competences applicable to all aspects of the profession and the competences that should be acquired through the academic programme. Information, support

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and care are integral components of every aspect of the radiotherapy process. We have incorporated communication and patient care and support in the treatment delivery section to avoid repetition and as this is the core activity of the RTT but it is inherent in all patient related activities.

4.1 CLINICAL COMPETENCES

4.1.1 Professionalism

Short description

The student must display a high standard of professionalism and integrity at all times. This includes professional appearance and manner, self-awareness and competency limitations, a high standard of ethical and moral behaviour, reliability and responsibility, respect for patients and autonomy.

| Learning Outcomes | Knowledge/Comprehension | Applications/Synthesis / Evaluation |
|---|---|---|
| Able to demonstrate professional behaviour | <ul style="list-style-type: none"> • Explain the legal and ethical guidelines related to the profession • Be aware of your own competency levels • Identify the elements that reflect professional appearance and manner | <ul style="list-style-type: none"> • Practice in accordance with legislation regulations and ethical guidelines • Promote collaborative practice |
| Able to demonstrate a sensitive and caring attitude to patients | <ul style="list-style-type: none"> • Explain the components of good communication • Describe the main personality types • Be aware of the patient' gender, age, cultural background, educational level and social situation. | <ul style="list-style-type: none"> • Analyse how the differences in personality influence approach • Self awareness of their own personality traits |
| Able to carry out best practice at all times | <ul style="list-style-type: none"> • Be familiar with current literature and evidence based best practice | <ul style="list-style-type: none"> • Critically evaluate and apply knowledge gained in solving problems |
| Able to participate in continuing professional development | <ul style="list-style-type: none"> • Appreciate the importance of maintaining your knowledge and skills | <ul style="list-style-type: none"> • Evaluate and justify your practice regularly |

4.1.2 Positioning and immobilisation

Short description

Patient positioning and immobilisation is one of the most important aspects of accurate and reproducible treatment delivery and is considered a core skill of the RTT. The student must understand the importance of correct positioning and how it can be achieved. This incorporates understanding the appropriate immobilisation methods and materials for each site, the referencing system, the physical and psychological condition of the patient and the limitations of both imaging modalities and treatment delivery.

From the survey all experienced RTTs are involved in the preparation of immobilisation devices.

In 40% of responses the RTT carries this out alone with 8% requiring additional training.

Experienced RTTs are also involved in the preparation of electron cutouts and bolus, the majority independently.

| Learning Outcomes | Knowledge/Comprehension | Applications / Synthesis / Evaluation |
|---|---|--|
| Able to correctly position the patient | <ul style="list-style-type: none"> Define the common co-morbid conditions that patients may suffer from Be familiar with the techniques and equipment used Know the protocols used in the department | <ul style="list-style-type: none"> Evaluate the patient condition and the limitations that may result from any co-morbid conditions Analyse the information and integrate to define the optimum patient position Inform the patient about the procedure |
| Able to prepare and / or produce immobilisation devices | <ul style="list-style-type: none"> Know the immobilisation devices available Know how to use each device Recognise the associated health and safety issues | <ul style="list-style-type: none"> Construct the most appropriate device for the individual patient within the context of the protocol Apply the necessary precautions in production |

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| | | |
|--|---|--|
| Able to complete accurate documentation | <ul style="list-style-type: none"> • Recognise the importance of accurate documentation • Know what should be included • Know to whom the documentation should be sent • Be aware of the legal issues relating to documentation | <ul style="list-style-type: none"> • Prepare the documentation • Inform all the involved areas/personnel • Ensure all legal requirements have been met |
| Able to carry out QA of immobilisation devices | <ul style="list-style-type: none"> • Recognise the importance of regular quality checks on immobilisation devices | <ul style="list-style-type: none"> • Implement correct storage and handling procedures for immobilisation devices • Carry out regular quality assurance checks on all immobilisation devices • Evaluate new devices prior to implementation |

4.1.3 Image acquisition and virtual simulation

Short Description

The RTT should be able to carry out the required procedures necessary for optimal image acquisition for treatment planning for all cancer sites while taking into account the patient's needs and limitations.

| Learning Outcomes | Knowledge/Comprehension | Applications / Synthesis / Evaluation |
|--|--|--|
| Able to appreciate the different applications of the imaging equipment | <ul style="list-style-type: none"> • Describe the various image processing tools that can be employed and appreciate their impact on image appearance | <ul style="list-style-type: none"> • Compare the different imaging modalities and the rationale for their selection • Assess the most appropriate image format and implement this in the context of virtual simulation |

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|--|--|---|
| <p>Able to acquire images on all equipment routinely used</p> | <ul style="list-style-type: none"> Describe the various types of imaging modalities that can be used for treatment planning purposes | <ul style="list-style-type: none"> Recognise the most appropriate method of imaging for treatment planning educate and inform the patient concerning the different imaging modalities/procedures used Apply the various techniques to optimise image quality including the use of contrast agents where appropriate Inform and educate the patient on the process Explain the principles of positioning and immobilisation to imaging department staff where necessary |
| <p>Able to apply appropriate scanning conditions / parameters</p> | <ul style="list-style-type: none"> Describe the parameters affecting image quality for different imaging modalities | <ul style="list-style-type: none"> Apply the ALARA (as low as reasonably achievable) principle during image acquisition and record the exposure dose |
| <p>Able to demonstrate the ability to interpret and understand acquired images</p> | <ul style="list-style-type: none"> Identify relevant anatomy in relation to the treatment sites covered | <ul style="list-style-type: none"> Evaluate the images acquired to ensure accurate identification of the organs at risk |
| <p>Able to assist in the virtual simulation procedure</p> | <ul style="list-style-type: none"> Describe the purpose and process of simulation Identify the limitations of each treatment unit Identify the influence of beam parameters | <ul style="list-style-type: none"> Discuss the precision, accuracy and attention to detail required in the simulation process Prepare and critically evaluate beam arrangements |

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| Able to set the reference / isocentre points | <ul style="list-style-type: none"> • Define and explain the different methods commonly used for referencing • Describe the coordinate systems used | <ul style="list-style-type: none"> • Select the appropriate referencing method for the individual patient to ensure reproducibility throughout the treatment process |
| Able to complete accurate documentation | <ul style="list-style-type: none"> • Recognise the importance of accurate documentation • Identify what should be included • Indicate who should be informed • Be aware of the legal issues relating to documentation | <ul style="list-style-type: none"> • Prepare the documentation • Inform all the involved areas/professionals • Ensure all legal requirements have been met |

4.1.4 Treatment planning

Short Description

All RTTs should be able to interpret and evaluate a treatment plan and compare it to the treatment prescription. In addition RTTs directly involved in the treatment planning process should be able to participate in the preliminary discussion on the issues relating to the optimum treatment plan for an individual patient and be able produce a treatment plan that fulfils the criteria.

In sixteen countries the RTT is involved in image fusion and in ten of these countries this is carried out alone. In 18 countries the RTT is involved in contouring the patient outline usually independently and in six countries outlining the tumour volume together with the clinician. Contouring the organs at risk is carried out by RTTs in twelve countries with a variation between departments as to the level of clinician involvement.

| | | |
|-------------------|---------------------------|---------------------------------------|
| Learning Outcomes | Knowledge / Comprehension | Applications / Synthesis / Evaluation |
|-------------------|---------------------------|---------------------------------------|

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|--|--|--|
| <p>Able to interpret and evaluate a treatment plan and compare it to the treatment prescription</p> | <ul style="list-style-type: none"> • Define the target and organs at risk using the ICRU terminology • Describe how DVHs are created and used to evaluate plans. • Relate the influence of changing planning parameters on DVHs. • List the dose restrictions for the organs at risk | <ul style="list-style-type: none"> • Assess the practical problems associated with machine and accessory equipment limitations and respond accordingly. • Critically evaluate the dose distribution and the DVHs • Transfer the patient data and images to the TPS and to the record and verify system and verify the plan |
| <p>Able to produce an appropriate treatment plan that meets the requirements of the treatment prescription</p> | <ul style="list-style-type: none"> • Explain the principles of a treatment planning system • Explain image fusion • Define the radiation sensitivity of tumours and normal tissues | <ul style="list-style-type: none"> • Evaluate the role of image fusion • Appraise fused images • Contour skin surface and organs at risk. • Evaluate the requirement for beam modification • Optimise and evaluate the plan options • Carry out manual calculations • Double check computer and manual calculations |

4.1.5 On treatment verification

Short Description

Before delivery of the first treatment the RTT must be able to check for consistency between the data in the record and verify system and the treatment prescription, the immobilisation and the setup and the beams with the treatment plan. The RTT must be able to carry out the patient position verification and record the reference data. S/he must be able to carry out verification

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checks and implement adjustments in accordance with departmental protocol. The RTT should be able to perform and evaluate images that are acquired during treatment to establish the accuracy of patient setup and to make adjustments in accordance with departmental protocol.

There was a wide variation in the responsibility taken by RTTs in respect of image verification. Even online verification frequently required input from the clinician but in seven countries RTTs could carry out this independently within protocol parameters.

| Learning Outcomes | Knowledge/Comprehension | Applications / Synthesis / Evaluation |
|---|--|---|
| Able to carry out the necessary data transfer checks | <ul style="list-style-type: none"> • Define and explain the data that must be transferred | <ul style="list-style-type: none"> • Check and verify all treatment parameters • Confirm approval and signatures |
| Able to prepare the patient for their first treatment | <ul style="list-style-type: none"> • Be familiar with the treatment plan • Identify all necessary preparatory procedures | <ul style="list-style-type: none"> • Inform and educate the patient as to the treatment procedures • Inform the patient of the possible side effects • Assess the physical and psychological status of the patient • Check all preparatory procedures have been completed |
| Able to position the patient as for treatment | <ul style="list-style-type: none"> • Explain the principles of positioning • Define the parameters routinely used | <ul style="list-style-type: none"> • Check all parameters are set correctly • Check all immobilisation and beam modification devices are correct and correctly positioned • Check reference or isocentre settings are correct |

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|---|--|--|
| Able to acquire the initial verification images | <ul style="list-style-type: none"> • Explain the different modalities/ methods used to generate verification images | <ul style="list-style-type: none"> • Select the correct settings to acquire an appropriate image |
| Able to carry out corrective actions | <ul style="list-style-type: none"> • Recognise the critical structures on the verification images • Identify the imaging protocol • Explain the position verification protocols commonly used | <ul style="list-style-type: none"> • Critically evaluate the verification images • Make corrections in accordance with the protocol |
| Able to check the dose delivered | <ul style="list-style-type: none"> • Identify the daily entrance and exit dose and dose level of critical organs | <ul style="list-style-type: none"> • Carry out in vivo dosimetry • Evaluate results and take corrective action as per protocol • Report any inconsistency |
| Able to implement health and safety procedures | <ul style="list-style-type: none"> • Explain the health and safety issues for patients and staff | <ul style="list-style-type: none"> • Assess the safety features to ensure they are in place and adhered to |

4.1.6 External beam treatment delivery

Short Description

The RTT is responsible for the accurate daily delivery of the prescribed treatment. This incorporates daily evaluation of the patient's physical condition to note, account for and seek advice for any significant change that may directly affect the delivery of the treatment as prescribed, checks for consistency of the positioning aids, image verification and all quality assurance procedures in accordance with department protocols.

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The RTT must be able to receive, process and provide information to staff, patients and their families and members of the public as appropriate and be able to differentiate and fulfil the informational requirement of each group. As the main contact point for the patient on a daily basis they must ensure that they inform the patient of the procedures at every stage and they must continuously monitor the physical and psychosocial status of the patient prior to any procedures taking place. They must make referrals to the relevant health professionals and ensure that all pertinent information is transferred accurately and concisely and in a timely manner.

From the survey all RTTs are involved in information giving and support for patients at the time of simulation and first treatment with experience required in 50% of the responses. In 50% of the responses the RTTs are involved at the time of the first patient visit and 30% are involved in the follow process. All RTTs support the patient throughout the treatment process.

| Learning Outcomes | Knowledge/Comprehension | Applications / Synthesis / Evaluation |
|--|--|---|
| Able to carry out the daily organisation of the treatment unit | <ul style="list-style-type: none">• Recognise the importance of team interactions• Explain the principles of effective communication• Review the individual patient requirements | <ul style="list-style-type: none">• Participate in the organisation of the daily work schedule to maximise efficiency |

ESTRO

| | | |
|---|---|---|
| <p>Able to accurately position all patients</p> | <ul style="list-style-type: none"> • Discuss the importance of patient identification and how it should be carried out • Be familiar with the treatment plans for all patients on the treatment unit • Identify the co-morbidities that will impact on patient position • Recognise the signs and symptoms associated with treatment in different sites | <ul style="list-style-type: none"> • Interpret the treatment plan and prepare the equipment accordingly • Identify the patient in accordance with recognised procedures and consistent with the department protocol • Evaluate the patient general condition prior to commencing positioning |
| <p>Able to carry out on treatment verification</p> | <ul style="list-style-type: none"> • Distinguish between systematic and random errors • Define dosimetric and geometric errors | <ul style="list-style-type: none"> • Compare and contrast bony anatomy and soft tissue matching • Evaluate the images • Make corrections in accordance with protocol • Record any corrections |
| <p>Able to monitor, manage and record the patient's side effects throughout the course of treatment</p> | <ul style="list-style-type: none"> • Identify the side effects associated with the individual treatment • Define the effects of concomitant treatment • List support groups that might benefit patients • Be familiar with the follow up procedures | <ul style="list-style-type: none"> • Assess the daily physical and psychological status of the patient prior to treatment • Advise the patient on management of side effects in accordance with departmental protocol • Refer the patient as appropriate • Record all side effects and any intervention recommended • Advise patient on immediate post treatment care and inform of the follow up procedures |

4.1.7 Quality Assurance

Short Description

The RTT is responsible for ensuring the quality of all procedures in which they are involved and should be familiar with and participate in the routine quality assurance and quality control procedures carried out in the department.

In twenty two of the responding countries the RTT carries out the daily QC checks and is involved in image matching for verification. In twelve countries an RTT is a member of the radiation protection committee and in fourteen countries involved in clinical audit in their department. In ten countries there is a defined QA post for RTTs.

| Learning Outcomes | Knowledge/Comprehension | Applications/Synthesis/Evaluation |
|---|---|--|
| Able to carry out the daily Quality Control checks | <ul style="list-style-type: none"> Explain QMS, QA and QC | <ul style="list-style-type: none"> Perform the daily QC procedures Analyse and record the results and report any deviations |
| Able to report incidents and near incidents | <ul style="list-style-type: none"> Be familiar with the reporting system and reporting protocols | <ul style="list-style-type: none"> Report incidents and near incidents to the multidisciplinary team Examine any incidents or near incidents and how they can be prevented in the future |
| Able to ensure radiation protection legislation is adhered to | <ul style="list-style-type: none"> Describe the radiation hazards and how they are managed Explain the legislation relating to radiation protection | <ul style="list-style-type: none"> Routinely inspect the area to ensure that radiation protection measures are in place and functional |
| Able to ensure that general health and safety procedures are adhered to | <ul style="list-style-type: none"> Identify the relevant legislation Describe the hazards that might be encountered and how they are managed | <ul style="list-style-type: none"> Routinely inspect the area to identify any health and safety hazards and report where necessary |

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4.1.8 Brachytherapy

Short description

The RTT must fully appreciate the fundamental principles involved in the delivery of brachytherapy. The RTT must be competent to participate in procedures including plan evaluation, treatment planning and carrying out QA and safety checks prior to treatment commencement as appropriate to practice in the department. These procedures should be carried out accordance with departmental protocols.

From the responses RTTs are involved in the room preparation and simulation procedures in twenty countries. In sixteen and seventeen countries respectively the RTT is involved in patient preparation and assisting with the procedure. In twelve and ten countries respectively the RTT is involved in treatment planning or dose calculation.

| Learning Outcomes | Knowledge/Comprehension | Applications / Synthesis / Evaluation |
|--|--|---|
| Able to prepare for the procedure | <ul style="list-style-type: none">• Identify the technique to be used• Identify the patient in advance and be familiar with their general condition• Evaluate the treatment plan | <ul style="list-style-type: none">• Arrange the treatment room and ensure all equipment is available• Assemble all the documents required• Inform the patient of the procedure• If appropriate participate in planning the treatment |
| Able to assist in the procedure | <ul style="list-style-type: none">• Identify the roles and responsibilities of the members of the team | <ul style="list-style-type: none">• Manage the aspects of the procedures that are the responsibility of the RT |
| Able to ensure radiation protection rules are adhered to | <ul style="list-style-type: none">• Recognise the specific radiation hazards associated with brachytherapy• Identify the routine QA and safety procedures that should be carried out prior to treatment | <ul style="list-style-type: none">• Check all radiation protection requirements have been met• Carry out the routine QA and safety procedures prior to treatment |

4.1.9 Research

Short description

The RTT should be able to evaluate and apply the results of research in their daily practice. They should be able to participate in research projects within their sphere of activity and to identify areas within their own practice that would benefit from research.

From the survey RTTs are involved in research and in twelve countries can initiate their own research ideas. In fourteen countries RTTs publish the results of their research.

| Learning Outcomes | Knowledge/Comprehension | Applications / Synthesis / Evaluation |
|--|--|---|
| Able to participate in the implementation of national or international clinical trials into the department | <ul style="list-style-type: none"> Review the trial documentation Be familiar with trial requirements | <ul style="list-style-type: none"> Set up the trial documents and introduce to the staff Confirm that all trial parameters are met |
| Able to carry out a literature search | <ul style="list-style-type: none"> Identify the correct search terms | <ul style="list-style-type: none"> Critically appraise the studies selected |
| Able to develop a research idea | <ul style="list-style-type: none"> Recognise an aspect of practice that would benefit from research | <ul style="list-style-type: none"> Collect all the information necessary to refine the research idea and plan the project |
| Able to write a research proposal | <ul style="list-style-type: none"> List all items to be included in the proposal Identify the ethical requirements | <ul style="list-style-type: none"> Organise all the elements necessary to write the proposal |
| Able to carry out the research | <ul style="list-style-type: none"> Introduce the research study to the staff Identify the patients who will participate if appropriate | <ul style="list-style-type: none"> Inform and educate the patients with respect to the requirement of the study Work within the defined time schedule Record the results |
| Able to analyse the data | <ul style="list-style-type: none"> Define the data analysis | <ul style="list-style-type: none"> Analyse the results |

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|--|---|---|
| | methods commonly used | <ul style="list-style-type: none"> Write up the research for submission to a scientific publication |
| Able to participate in the implementation of the research findings | <ul style="list-style-type: none"> Recognise when multidisciplinary input is necessary | <ul style="list-style-type: none"> Monitor if adaptation of the protocol is necessary Work closely with the multidisciplinary team in implementing the research finding |

4.1.10 Education

Short Description

The RTT should be prepared to teach / support / supervise new colleagues of all disciplines in their department. He/she should participate in education programmes for student RTTs and other health related disciplines. He/she should participate in public information sessions and patient information and education programmes.

| Learning Outcomes | Knowledge/Comprehension | Applications / Synthesis / Evaluation |
|--|--|--|
| Able to inform and educate other RTTs and healthcare professionals on radiotherapy | <ul style="list-style-type: none"> Explain the basic procedures carried out | <ul style="list-style-type: none"> Evaluate the optimum method to impart information to other RTTs and health professionals |
| Able to participate in clinical education of student RTTs | <ul style="list-style-type: none"> Discuss the educational methods most appropriate to clinical education | <ul style="list-style-type: none"> Inform and educate student RTTs on all aspects of clinical practice |
| Able to participate in patient information and education sessions | <ul style="list-style-type: none"> Describe the preparation and treatment procedures | <ul style="list-style-type: none"> Prepare information for the patient sessions |

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5.0 Curriculum topics

The following section provides detail on the required areas of knowledge necessary to develop the competences for practice. It is divided into two sections: section 1 outlines the basic science subjects which underpin the discipline specific subjects and section 2 outlines the discipline specific content.

5.1 GENERAL ACADEMIC COMPETENCY CONTENT

Based on Bloom's taxonomy students should be able to display knowledge and comprehension with limited application, of the basic science topics underpinning all aspects of radiotherapy preparation and delivery and patient support. In this taxonomy knowledge is defined as the ability to recall or remember facts and comprehension the ability to understand and interpret learned information. The basic science subjects necessary for the practice of radiotherapy are:

5.1.1 Biology

The course should include sufficient basic biology to provide the students with a background which will enable them to explain the biology of normal tissue and cancer and evaluate treatment plans in this context.

5.1.2 Chemistry

The course should include sufficient basic chemistry to provide the students with a background which will enable them to explain the interaction of cancer treatments with malignant and normal tissue.

5.1.3 Physics (including basic mathematical concepts)

The course should include sufficient basic physics to provide the RTTs with a background which will enable them to describe the equipment used in radiotherapy and the interactions of radiation and matter. The mathematical concepts should be sufficiently robust that students will be able to carry out treatment planning and dose calculation.

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5.1.4 Biochemistry

This course should link the concepts acquired in Chemistry and Biology. The student should be able to synthesise their knowledge and apply this to the study of radiobiology and the understanding of acute and late side effects of cancer treatment.

5.1.5 Anatomy

The student should be able to recognise structures and organs and their relationships and identify and interpret the radiological images used in the preparation and delivery of radiotherapy.

5.1.6 Physiology

The student should be able to describe the function of organs and body systems and how the interaction with cancer treatments affects function.

5.1.7 Psychology

The student should be able to discuss the theories of psychology that are directly related to health and healthcare and evaluate their relevance to the cancer patient and their management.

5.1.8 Information Technology

The student should be familiar with all aspects of information technology and be able to apply this acquired knowledge and skills in a clinical and research setting.

5.2 RADIATION THERAPY SPECIFIC COMPETENCY

Based on Bloom's taxonomy students should be able to analyse, synthesise and evaluate the information acquired in the competency specific modules in radiotherapy preparation and delivery and patient support. In this taxonomy analysis is the ability to break down the information into its component parts and look for interrelationships and ideas, synthesise the

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information by combining information from a range of settings or experiences and evaluate or judge the value of the information and how it is best applied.

5.2.1 Radiation Physics

Competences and skills

The student should be able to:

- Describe nuclear structure, radioactive decay and the interaction of radiation with matter.
- Define the properties of particle and electromagnetic radiation
- Explain how they are applied in external beam therapy and brachytherapy

Curriculum content

- Radioactivity
- Interaction of radiation with matter
- Imaging methodologies for radiotherapy
 - Treatment preparation
 - CT
 - MRI
 - PET
 - Ultrasound
 - Simulator
 - Imaging for treatment verification
- External beam
 - Generation of photon, electron and particle beams
- Superficial, Orthovoltage, Cobalt including Gamma Knife, Linear Accelerator – photons and electrons, Particle beam generators, Cyberknife, Stereotactic, Intraoperative
 - Generating mechanisms
 - Physics and beam characteristics
 - Design features of the equipment used and the treatment rooms

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- Brachytherapy
 - Design features
 - Radiation sources
 - Radiobiology
 - Technique
 - HDR
 - LDR
 - PDR
 - Planning and Dosimetry

- Radiation protection and how it applies to the general public, patients and staff.
 - Radiation detection
 - Legislation
 - Basic Safety Standards Directive
 - The Medical Directive
 - Clinical Audit
 - ICRP

- Radiation protection as it applies to brachytherapy

5.2.2 Principles of Oncology

Competences and skills

The student should be able to

- Describe the process of malignant transformation
- Identify the methods of spread.
- Explain the interaction of radiation and cytotoxic/ targeted therapies with malignant and normal tissue and the influencing factors.
- To apply this knowledge when preparing and/or interpreting a treatment plan.

Curriculum topics

- Aetiology and epidemiology
- Genetics in the context of cancer

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- Carcinogenesis including methods of spread and cellular control mechanisms
- Basic pathology and histology
- Radiobiology/ molecular oncology
 - Cell kinetics
 - Cell cycle control mechanisms
 - Tumour biology
 - Metastases
 - Five R's of Radiobiology
 - Tissue structure and radiation effect
 - LQ/ Alpha Beta concepts
 - LET, RBE and OER
 - TCP / NTCP
 - Acute and late side effects
 - Sensitizers/Protectors/side effect reduction
 - Fractionation
 - Treatment combinations
 - Treatment scheduling
 - Treatment interruption and compensation

5.2.3 Cancer Prevention and Early Detection

Competences and skills

The student should be able to

- Discuss the importance of primary prevention.
- Outline the causative factors, early signs/symptoms
- Explain why early detection of cancer is important.
- Transmit this information to the general public.

Curriculum topics

- Promoting a healthy lifestyle
- Early detection
- Signs and symptoms
- Public awareness of early signs and symptoms

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- High risk groups
- Screening programmes
- Effective communication of primary prevention

5.2.4 Cancer Diagnosis

Competences and skills

The student should be able to:

- Explain the different diagnostic modalities, their role in the diagnosis and staging of cancer
- Interpret the TNM and other commonly used staging systems
- Apply this information in treatment preparation and patient monitoring.

Curriculum topics

- Clinical investigation
 - Determining tumour and lymph node status
 - Patient performance status
- Laboratory investigations
- Diagnostic Imaging
- Exploratory surgery including biopsy
- Staging and Grading

5.2.5 Treatment Decision and Modalities

Competences and skills

The student should be able to:

- Identify the reasons underpinning the treatment intent and the treatment most appropriate for the common malignancies
- Explain the principles of multi-modality treatment

Curriculum topics

- Treatment intent and how the decision is reached
 - Role of the multidisciplinary team

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- Radical
- Palliative
- Treatment regime
- Methods of treatment
 - Surgery
 - Chemotherapy
 - Immunotherapy
 - Hormonal therapy
 - Radionuclide therapies
 - Targeted therapies

5.2.6 External Beam Radiotherapy

5.2.6.1 Patient positioning and immobilisation

Competences and skills

The student must be able to:

- Apply the principles of positioning and immobilisation
- Identify and construct the most appropriate immobilisation devices with consideration for the individual patient's condition.

Curriculum topics

- Laser/ positioning systems
- Marking systems
- Positioning Aids
 - Breast boards
 - Lung boards
 - Bellyboards
 - Thermoplastics
 - Vacuum packs
 - Stereotactic systems
- Documentation
- Quality control of immobilisation devices

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5.2.6.2 Internal organ motion control

- Bite blocks
- Gating systems
- Active Breathing Control
- Diaphragm compression
- Markers and Tracking systems

5.2.7 Image Acquisition for Planning Purposes

Competences and skills

The student must be able to:

- Identify the most appropriate methods of imaging for treatment planning for the most common tumour sites
- Acquire the optimal quality images in the treatment position considering the individual patient condition.

Curriculum topics

- Image Quality
 - Factors affecting quality of
 - Artefacts
 - Contrast Media
 - ALARA principle
- Modalities for image acquisition for planning
 - CT
 - MRI
 - PET
 - Ultrasound
 - Plain radiography
 - Other
- QA of imaging modalities
- Isocentre and reference points determination and documentation
- Physical and electronic handle images

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5.2.8 Treatment Planning

Competences and skills

The student should be able to:

- Demonstrate a working knowledge of treatment planning principles
- Demonstrate an understanding of multi-modality image registration and fusion for target volume delineation
- Produce computer based plans and carry out dose calculations with the appropriate use of photon and electron beam
- Produce optimal plans according to the guidelines

Curriculum topics

- ICRU terminology
- Contouring Methods
- Image fusion
 - Bony matching
 - Soft tissue matching
 - Deformation registration
- Dose Calculation
 - Percentage Depth Dose (PDD), Tissue Air Ratio (TAR), Tissue Maximum Ratio (TMR), Tissue Phantom Ratio (TPR),
 - Influence of shielding and FSD on the dose distribution
 - 2D
 - 3D
 - 4D
 - Inverse planning for IMRT
 - Beam shaping and modification
- Treatment Planning Systems (TPS)-algorithms
 - Hounsfield units
 - Calculations
 - ICRU recommendations
 - Dose limits and determinants

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- Treatment plan analysis and evaluation
- Documentation

5.2.9 Radiotherapy Delivery and Image Acquisition for Treatment Verification

Competences and skills

The student should be able to:

- Correctly execute the approved treatment plan, giving consideration to the treatment regime
- Correctly position and immobilise the patient and apply the treatment set up as prescribe
- Evaluate the general condition of the patient
- Demonstrate a good understanding of the different verification systems (imaging and dose) and demonstrate a working knowledge of their use in different clinical settings using appropriate documentation.

Curriculum topics

- Synergetic effects of other forms of treatment with radiotherapy.
- Set-up
 - Manual
 - Computer assisted
 - Indexing
 - Referencing
- Patient preparation protocols
- Data verification, registration or recording
- Dose monitoring
- Dosimetry
 - In vitro
 - In vivo (TLD, Diodes etc)
- Imaging Modalities for Verification:
 - EPID and Portal imaging
 - CBCT
 - Ultrasound
 - And others

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- Imaging Protocols
 - On-line/off-line corrections
 - Matching/co-registration methodology
 - Geometric Uncertainties
- Advanced Techniques
 - IMRT (step and shoot and dynamic)
 - Total Body Irradiation
 - Stereotactic
 - Cranial
 - Extracranial
 - Total Skin Irradiation
 - Intra-operative
- QA of imaging modalities
- Documentation

5.2.10 Patient Care and Support

Competences and skills

The student should be able to:

- Describe the side effects associated with the common forms of treatment used in the management of the cancer patient
- Evaluate and document the radiotherapy side effects using recognised scoring systems and manage these throughout and following a course of treatment.
- Monitor patients' condition (physical, social and psychological) when they present for daily treatment
- Define and identify specific conditions/actions to be taken
- Have an awareness of the impact of the disease and treatment on the quality of life of the patient and their family
- Demonstrate effective communication skills within the multi-disciplinary team and with patient
- Build appropriate relationship with the patient.

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Core curriculum

- Radiotherapy related side effects
 - Acute
 - Late
- Monitoring side effects using scoring systems
- Management of side effects
 - Patient information
 - Symptomatic care of patient
- Monitoring patients' health
- Psychological and Social Issues and Support
 - Patient and Family
 - Counselling Skills
 - Individual and group support
- Effective Communication
 - Multidisciplinary team
 - Patient and Family

5.2.11 Quality Assurance and Risk Management

Competences and skills

The student should be able to:

- Demonstrate a knowledge of the fundamentals of quality assurance as applied to radiotherapy
- Participate in quality assurance and safety policies
- Demonstrate an awareness of the potential risks related to radiation treatment and patient related conditions
- Explain and apply the principles of radiation protection in daily practice.

Core curriculum

- Quality Assurance / Control
 - Equipment
 - Procedures (Evidence based)
 - Protocols (Evidence based)

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- Audit
- Incident registration
- Health and Safety
 - Manual Handling
 - Occupational injury
 - Fire safety
 - Infection control
- Risk management
 - Quality Management
 - Learning from incidents and near incidents
 - Incident reporting
 - Feedback
 - Action
 - Responsibility levels
- Radiation protection
 - Patients
 - Staff
 - The public

5.2.12 Management

Competences and skills

The student should be able to:

- Demonstrate an understanding of the principles of management in the context of the radiotherapy department, the hospital and the national healthcare system.
- Discuss the legal issues relating to healthcare delivery.

Curriculum topics

- Health care structure
- Hospital / hospice / home care
- Departmental management
- Career structure
- Legal issues

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- Ethics
- Data protection
- Confidentiality
- Patient rights

5.2.13 Research and Methodology and Statistics

Competences and skills

The student should be able to:

- Demonstrate knowledge of the fundamentals of research in a clinical setting.
- Participate in and contribute to research activities
- Synthesise research evidence to change practice.

Core curriculum

- Statistics
- Research Methodology
- Referencing
- Critical analysis of literature
- Ethics
- Documentation
- Clinical trial protocols
- The Helsinki Declaration

6.0 Teaching Methods

Whatever the teaching method selected it is important to engage with the students on the course and to encourage them to actively participate in the learning process. It is important to ask questions and discuss topics raised even if not directly related to the lecture itself. Where you, as the teacher, are unsure of an answer or simply do not know then tell the student that you will find out and ensure that you get back to them as quickly as possible. Students should be encouraged to find information themselves and directed to appropriate sites. Feedback by each student to the class generates more active participation.

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Remember also that learning takes place in many settings and environments. It is important to encourage students to think widely and see how courses integrate and influence each other, how content can be applied in different ways to solve problems and how life experiences can also contribute.

The teaching method should be clearly linked to achieving the learning outcomes defined for the course. A variety of methods can be used depending on the topic, content and the depth of knowledge required covering the spectrum for example from simple dissemination of information to helping students to apply knowledge to solve problems.

Timing is essential when the lecture is the chosen teaching method. It is generally acknowledged that the attention span varies throughout the traditional lecture and active breaks where a question is posed, teaching technique changes etc. are useful tools to keep the students attention. Students should be encouraged to collaborate together as this enhances the learning experience for all. It is important to remember that students also have a responsibility for their own learning.

In reality resources frequently dictate the type of methods used and in this case you must try to optimize the method as far as possible within these constraints.

The most common teaching methods are outlined below. Each lecturer and/or faculty must decide which method or methods best suits their programme in the context of their resources, expertise and expected learning outcomes.

6.1 Lecture

This is perhaps the most traditional teaching method and has many advantages as well as limitations. It is most suitable for large groups where what is required is the delivery of factual information. The greatest limitation is that the audience is often passive and communication is frequently one way. It is difficult in this context to gauge what students are learning outside of the examination process. However this type of presentation can be made more interesting. Where possible give examples in practice of the topic you are teaching, break the lecture into

ESTRO

discrete time blocks separated by a question, short discussion, worksheet to complete etc. This helps to maintain the concentration of the students. It can be useful to have a guest lecturer who will give an overview of the topic or set the scene as it were and you can then develop the concepts in smaller learning units. This can be particularly useful in relation to site specific malignancies with clinicians giving an overview of the disease and general management and the RTT covering the practical aspects of treatment preparation, delivery and patient care.

6.2 Laboratory Based

Laboratory based education allows the students to learn and train outside of the clinical setting, without interfering with clinical patient data and with the added benefit of repetition of the exercises until the defined competence has been achieved. The students have the possibility to ask questions without disturbing the staff and the patient. The value of the different laboratory learning methods will vary with the resources available and the skill and expertise of the lecturer.

6.3 Clinical Topics

Where the topic has a clinical base such as positioning and immobilization several approaches can be used. Where resources permit basic immobilisation devices should be available in the academic setting on which students can practice patient preparation and immobilisation mask production. More sophisticated 3D simulation systems are also available and can be very useful in student teaching. Access to systems or equipment will be determined by available resources and may be restricted if the workload in the clinical department is very heavy. Clinical education takes place in the clinical department during working hours but it may also be possible to use the clinic outside of treatment times to demonstrate accurate positioning for instance and where resources are very limited this is a very effective method.

6.4 Tutorials

Tutorials are an excellent way of encouraging student participation. They may be stand alone or offered to support lectures. In these tutorials the student is usually given some preliminary work to do and the tutorial then becomes an active discussion on the topic. It is useful for clarification of problems or to stimulate students to take greater responsibility for their own learning. It is

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important to identify clearly the topic for discussion and to give reference material and details on where additional material can be sourced.

6.5 Journal Club

Similar to the tutorial but the students are given a selection of journal articles on a specific topic and asked to analyse them and feedback during the session. This helps students to critically read articles and to differentiate between the quality of the research carried out and presented. This can also be very useful in providing students with the most current information on a topic such as site specific treatment.

6.6 Case Studies

This method can be very useful in radiation therapy as it directly relates theory and practice. Real clinical issues can be raised and discussed and this helps the students to consider problems and ways in which they can be addressed. It allows individual experiences and situations to be considered and doesn't necessarily impose solutions that may not be applicable in your situation. This type of approach also encourages professionalism an essential attribute of an RTT.

6.7 Problem based learning

First developed in McMaster University, Canada this is a student-centred approach where a problem is set to a group of students who must then divide the problem into separate components and allocate tasks to individuals within the group. The sub-groups arrange meetings and feedback session where the information obtained is shared with the full group and discussed in the context of the problem set. It is an excellent learning method but is resource intensive and often difficult to implement where resources are limited. It encourages active learning and enquiry on the part of the student, collaboration and communication skills. It should provide the student with lifelong skills in terms of addressing difficulties that subsequently arise in the clinical setting.

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6.8 E-learning

E-learning includes all forms of electronically supported **learning** and **teaching** and comprises the transfer of skills and knowledge through the use of computers and networks. With this method, students can have access to course content using processes such as Web-based learning, computer-based learning, virtual classrooms and digital cooperation. This requires properly trained staff who understand the content area, and are also trained in the use of the computer and the Internet to be able to work with students on-line. This can be a very useful method for students during clinical placement.

7.0 Assessment

Assessment is the process of documenting, usually in measurable terms, the extent to which the learning outcomes have been achieved and can cover knowledge, skills, attitudes and beliefs.

Assessment plays a very important part in the education process and often dictates what a student will learn. It determines both how and what we teach to a large extent. It should not simply be about the allocation of grades but should help to inform and support student progress and identify areas where additional input is required. Assessment should be seen as facilitating learning and should focus on what is learnt rather than what is taught again consistent with Bologna and the focus on learning outcomes.

Assessment should be transparent and assist rather than intimidate students. There is nothing worse than learning large volumes of information and not being able to apply it in the examination. In this context assessment should reflect the learning outcomes and measure to what extent they have been met – an evaluation of the effectiveness of the teaching process. It can be used by the faculty to measure how effective the linkages between the learning outcomes and the teaching methodology have been and indicate areas where further review is required.

Assessment can be classified in many different ways, some of the most usual are:

- Formative or Summative
- Objective or Subjective
- Formal or Informal

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Summative occurs at the end of a course and its purpose is generally to enable the awarding of a grade where formative takes place throughout a course or project and is used to aid learning and give continuous feedback on performance to students. These two methods are routinely used in larger courses to complement each other.

Objective assessment in its simplest explanation is the use of a form of questioning where there is a single correct answer. This could perhaps be something like an MCQ or a mathematical calculation as in dose/fractionation calculations. Subjective on the other hand may have more than one correct answer or there may be more than one way of answering the questions. Essays can be considered in this way and again an example would be the treatment of a tumour site where more than one option could be considered as correct.

Informal assessment doesn't usually require a written answer and can be very useful in guiding students during class or practical sessions. Informal assessment can include observation, peer and self evaluation, discussion, checklists etc. Formal assessment, on the other hand, usually implies a written examination in some format and may be external.

Assessment is one of the most obvious ways to evaluate what the student has understood, whether they can apply the knowledge and/or carry out the particular practical skill or whether they have developed the affective skills such as good communication. It is also a means of evaluation of the effectiveness of the programme as a whole and its individual components.

Assessment should be an integral component of course design and the amount and level of assessment should be consistent with the defined learning outcomes. It is about finding out what the student has achieved and giving it a value.

Outlined below are some of the common methods used in student assessment. The individual lecturer or faculty must decide on the most appropriate form of assessment for their subject based on the content, learning outcomes and available resources.

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7.1 Methods of Assessment

Assessment can and should take many forms thereby testing a wide range of knowledge, skills and attitudes consistent with the taxonomy defined by Bloom.

In all assessment that will be allocated a mark or grade it must be made clear to the student as to how the marks are going to be allocated. This will also indicate to them the level of detail required on each aspect of the topic.

7.1.1 Traditional Examination

These are usually unseen and at the end of a block of learning either a module or end of a full academic year. With this type of assessment it is at least generally fair and consistent from the student perspective and what is returned is verifiable as the student's own work. When examinations are at the end of a module they have less benefit in terms of feedback and improvement. It is quite difficult to write clear and unambiguous questions. In addition, some students are naturally better at sitting examinations, have greater ability to recall large numbers of facts, to set out answers clearly or even to write faster. The answers may not always reflect either the level of understanding of the student or the ability to apply knowledge in a wider context.

When writing examination questions it is useful to do it with at least one other person and to ask somebody to read them for clarity when completed. The focus of the question must be clear and reflect what exactly what is being tested. It is useful to answer the question yourself and to use this as a guide to marking. However you must remember that there may be other points of view or approaches to answering the question and not penalise students who don't give back exactly what you drafted in your sample answer. This necessitates a high level of knowledge on the part of the examiner.

7.1.2 Open book examination

This is similar to the traditional examination but the student is able to take source or reference material into the examination with them. This is a useful method where a lot of factual information is required in the answer but that does not necessarily have to be learnt and remembered by the student. This method of assessment can also be used to assess how well

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students can use source or reference material and apply the information **gained** to a specific question or problem. This is a valuable skill for RTs to have in their future working lives.

7.1.3 Types of questions used

Long essay type questions are used where students are expected to apply principles or knowledge to a given situation. Students will usually be expected to give an opinion or to draw from other experiences they may have had. This type of question gives the student the opportunity for self expression and to show wider reading or understanding and must be marked with this in mind. Long essay can disadvantage students whose vocabulary is limited or who have poor essay writing skills.

Short answer questions are used to test maybe a single more specific aspect of a topic. They are used to test a breadth of knowledge over a wider range of topics. You may prepare a full exam paper of short answer questions or may choose to have one of the essay questions with several parts reflecting the learning outcomes defined initially.

7.1.4 Multiple Choice Examinations

In this form of assessment students are asked a question or presented with a statement, **the stem**, and given a set of possible answers from which, in its simplest form they must be required to select the correct answer. The correct answer is termed **the key** and the incorrect answers **the distractors**. Stems should be clear, the key should be leave no area for doubt and the distractors should be incorrect but not ridiculous. They should test the students' knowledge directly. MCQs can take a range of forms and can include diagrams, short scenarios, case studies etc. It is also possible to test depth of knowledge by developing a linking series of MCQs on a single topic. Well written MCQs can be a very effective method of assessment.

7.1.5 Portfolio

The portfolio is a compilation of a range of work built up over a period of time and has the advantage of showing evidence of the student's achievement over time. The portfolio can also be very useful for graduates applying for positions or for CPD in the future. The biggest disadvantage is for the teacher as they are time consuming and difficult to mark. For clinical practice they are an excellent method.

ESTRO

7.1.6 Reflective Diaries

These allow the students to record experience and to reflect what they have learnt from them. They help to students to focus on what they have learnt and the integration into their thinking. They are used to record experience and to help understanding, to increase the ability to consider a problem or experience and reflect on how you did or may address it. It is applicable in the clinical setting later in encouraging practitioners to think about what they are doing, why and is there a way to do it better.

7.1.7 Viva Voce or Oral examinations

These are usually used in conjunction with other assessment methods and give students an opportunity to clarify points that were unclear from their examination papers or to demonstrate a higher level of knowledge and understanding. They can also be used in place of a practical examination to test the application of knowledge to the clinical setting. This can be useful when resources are scarce and practical examinations cannot be arranged. It is advisable to have both academic and clinical examiners to assess how well the student is linking theory and practice.

7.1.8 Objective Structured Clinical Examination (OSCE)

These are very frequently used in the medical setting to test practical skills or affective skills such as communication. They normally consist of several stations, where a station is a discrete section within a specially laid out room where a single topic is assessed. Students are expected to move through each of the stations and to answer the problem set within a defined time period usually 5-10 minutes. The stations may ask a dose calculation question, may set a case scenario and ask the student how they would deal with it, in more sophisticated systems actors may be used to present the student with a problem where their ability to communicate can be tested. OSCE are very useful in testing a range of skills but can be subjective. Great care must be taken in both setting and marking the stations.

7.1.9 Presentations

These can be a very good method of assessment particularly for a short course. You can test the knowledge of the student who will have to prepare the presentation but also the level of depth and understanding that they have achieved through questioning following the presentation. Students are also gaining a useful secondary skill that they can use later and they can be

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encouraged to prepare presentations for future study days, workshops, conferences etc. They learn the skills of communication, how to stand and project themselves and their voices to give the maximum benefit to their presentation.

7.1.10 Posters

Posters are similar to presentations in requiring students to summarise their learning or research findings in a concise way identifying the most important aspects and exploring how to present them to give best effect. This is also a very useful skill to give the students for their future life and can encourage them to participate in activities where they may previously have not felt confident enough.

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