## Radiation Oncology Training for the Medical Oncologist

The ACVR/ACVIM Resident Training Objectives Committee's interpretation of the Training Manual as pertains to the radiation oncology training requirement for the medical oncology resident: The radiation oncology requirement consists of 8 weeks of clinical practice under the direct supervision of a radiation oncologist, defined as face-to-face contact on a daily basis. Stated training goals include development of an understanding of clinical management of patients receiving radiation therapy, radiation planning, dosimetry and physics related to clinical radiation therapy.

The Committee agrees that the radiation oncology-training goal for medical oncology residents should be to teach conceptual knowledge required for medical and radiation oncologists to work together as informed partners in a multidisciplinary setting. The aim should not be to train medical oncologists to administer radiation treatments nor to serve as substitutes for radiation oncologists. Development of hands-on skills in radiotherapy implementation should not be the primary focus. Rather, training should aim to produce fluency in the language and nuances of radiotherapy, its applications and limitations, as well as to develop clinical competencies in radiation patient management. The scope of training should extend beyond what is needed to pass the current radiotherapy component of the certifying exam.

It is the expectation of the Committee that the teaching objectives below can be completed over the course of an 8-week training period. The committee supports training blocks of a minimum of two weeks in duration. This allows residents the opportunity to diversify their training experience and to be exposed to different radiation delivery technologies. The Committee foresees that residents may use the objectives as a checklist to direct their training.

### Specific Teaching Objectives for 8 Weeks of Directly Supervised Clinical Practice

- Understand the principles of 2D radiotherapy (2D RT), 3D radiotherapy (3D RT), intensity modulated radiotherapy (IMRT), image-guided radiotherapy (IGRT), stereotactic radiosurgery (SRS) and stereotactic body radiotherapy (SBRT). Understand how these techniques differ in application, potential outcome and risk of side effects

    - The committee recognizes that there is a spectrum of radiation technologies in use in veterinary medicine. A resident should have an understanding of how clinical outcomes and side effects can differ when different techniques are used. Regardless of whether residents receive training at one or multiple facilities, they should develop at least a conceptual familiarity with the breadth of techniques available and the basic principles of each

    - Understand the factors associated with appropriate selection of radiotherapy technology

- Understand the basic principles, advantages and limitations of advanced technologies available for delivery of IMRT, IGRT and SBRT in veterinary medicine (i.e. linear accelerators, Tomotherapy, Cyberknife, etc.)

- Radiotherapy treatment planning
    - Participate in the development and refinement of radiation therapy treatment plans
        - Manual and computer-based plans
    - Understand the differences between 2DRT, 3DRT and IMRT planning.
    - Manual planning (point-dose calculations) vs. computer planning
    - Forward vs. inverse planning
    - Understand the impact of beam-modifying devices such as wedges, blocks, multi-leaf collimators, bolus and compensators
    - Define and understand the role of target delineation using GTV, CTV, ITV and PTV, as well as normal tissue contouring (organs at risk) in treatment planning
    - Understand the influence of internal organ motion (e.g. breathing)
- Recognize the advantages and limitations of MRI-based treatment planning
- Contouring exercises:
    - Demonstrate the capacity to delineate tumor volumes and normal tissues as part of the contouring phase of computer-based radiation treatment planning
    - Develop an appreciation for the time demands of contouring, the subjectivity of the process and the potential clinical consequences of variability in contouring practices
- Be able to interpret and critique treatment plans
    - Evaluate dose volume histograms, dose distributions, target volume coverage, conformation of dose
- Normal tissues
    - Understand the role of normal tissue tolerance in treatment plan development
    - Know that there are gaps in normal tissue tolerance knowledge in veterinary species and understand that, in the absence of animal information, tolerances established for people are extrapolated to veterinary medicine
    - Recognize the relevance of parallel vs. serial organ classification

- Radiation toxicity
    - Understand the nature and behavior of acute and late toxicities, and what tissues are affected
    - Know the indications for medical and surgical management for acute and late radiation toxicities
    - Understand the relationship between fractionation (dose/fraction) and the risk of normal tissue complications
    - Recognize the potential for toxicity associated with combination therapies (radiation and surgery, radiation and chemotherapy, radiation and biological therapies)
    - Understand the principle of radiation recall.
    - Be able to apply the VRTOG radiation morbidity scoring scheme to quantify early and late effects
- Radiation biology and physics
    - Understand the basic processes involved in the generation of ionizing radiation.
    - Differentiate the types of ionizing radiation used in veterinary radiotherapy
    - Photons vs. electrons vs. beta particles
    - X-rays vs. gamma rays
    - Orthovoltage vs. megavoltage
    - External beam radiotherapy vs. plesiotherapy vs. injectable radiotherapy
    - Understand the differences between a linear accelerator and a cobalt-60 unit for external beam radiotherapy
    - Understand the concept of skin sparing
    - Understand key concepts described in Hall's textbook "Radiobiology for the Radiologist"
        - Understand the basic interactions of ionizing radiation with tissue.
        - Understand the mechanism of cell killing by ionizing radiation

        - Be able to clinically apply the concepts described by the 4 R's of fractionation
        - Understand the concept of the linear quadratic model and the alpha/beta ratio
        - Understand the application of the biological effective dose (BED) and EQD2 equations

- Administration of radiation therapy
    - Observe and participate in all aspects of external-beam radiation delivery
        - Photon and electron therapy
    - Patient immobilization
        - Understand the importance of accurate patient positioning
        - Understand the use of available immobilization devices
        - Bite blocks, body mattresses, thermoplastic masks, etc.
    - Patient position verification and target delineation
        - Understand the use of position verification technologies in use in veterinary medicine including 2D gantry mounted imaging (KV, MV), cone beam KVCT, helical MVCT, room-mounted 2D imaging
    - Electron beam therapy
        - Understand the benefits, applications and limitations
    - Plesiotherapy
        - Know the indications for and limitations of strontium-90 in therapy
        - Understand the principles of radiation safety in plesiotherapy
    - Radiation safety and protection
        - Have a healthy respect for radiation safety
        - Understand the concept of ALARA
        - Understand the concepts of stochastic vs. deterministic effects
    - Be aware of the following policies
        - Recommended dose limits for public and occupational workers

        - Declaring a pregnancy at the workplace

    - Know the role of a radiation safety officer and a medical physicist in radiation safety

    - Understand the importance and relevance of quality assurance and the role of the medical physicist in a radiation oncology practice

- Case management

    - Develop proficiency in the management of radiation-induced side effects

    - Recognize the importance of multidisciplinary collaboration prior to surgery when combining with radiation

    - Role of fiducials in delineation of the surgical field

    - Role of incision placement

    - Recognize limitations of radiation planning when targets are irregularly shaped and/or in close proximity to critical normal tissues

    - Participate in treatment planning CT set-ups

    - Participate in the decision-making process regarding the selection of radiation therapy as a neo-adjuvant, adjuvant or primary therapy

    - Understand and participate in the decision-making process regarding selection of appropriate radiation therapy technology and protocol

    - Know the indications for and limitations of palliative vs. definitive treatment approaches

- Witness and participate in client interactions between the radiation oncologist and the pet-owner from diagnosis through end-of-life discussions. Recognize effective communication styles and approaches to client education

- Attend and participate in journal club (if available) with an intent to gain an awareness of and to critically assess the literature (veterinary, human or basic science)