Joint Symposium 16

Dosimetry + Translational and Molecular Imaging & Therapy Committee / European Society for Radiotherapy & Oncology (ESTRO)

Monday, October 14, 16:30-18:00

Session Title

Dosimetry in Preclinical Setting to Determine Dose Limits and Extrapolation to Clinical Dosimetry

Chairpersons

Lidia Strigari (Bologna, Italy)
Iuliana Toma-Dasu (Stockholm, Sweden / ESTRO)

Programme

16:30 - 17:00	Iuliana Toma-Dasu (Stockholm, Sweden / ESTRO): Variable Proton RBE - Is it Time to Reconsider the Dose Limits for Normal Tissues?
17:00 - 17:30	Robert Hobbs (Baltimore, United States of America): The Physics of Radiobiology for Alpha-Particle Radionuclide Therapy Effects
17:30 - 18:00	Julie Nonnekens (Rotterdam, Netherlands): The Biology of Radiobiology Markers for Dose-Effects in Radionuclide Therapy

Educational Objectives

1. Learn methods in external ion beam radiotherapy to derive equivalent dose-response relations
2. Understand the physics in the radiobiology of dose-effect relations after radionuclide therapy
3. Understand the biology in the radiobiology of radiation-induced DNA and related damage

Summary

Translation of animal PK and dose effects into relevant clinical end-points in radionuclide therapies has focused mainly on the bio-physical aspects of absorbed dose rate and response equivalent dose. Determination of the Relative Biological Effectiveness (RBE) from high LET radiation exposure forms an important issue both in external beam therapy with proton and ion beams as well as in radionuclide therapies with alpha-particle emitters. Comparisons of cell survival of the high LET exposure with a standard low-LET photon exposure at a fixed end-point is not considered to cover the complexity of the LET spectra in the clinical practice. Several methods have been developed to derive the RBE over the whole response curve. Better knowledge of the RBE (linked to relevant clinical end-points) helps in prescribing the relevant photon/electron equivalent dose, with better known clinical experience.

Physical properties of hadron beams change significantly as particles propagate in patient tissues. This causes the RBE to change. Several different approaches are used in clinical settings to address the RBE evaluation of ion beams. In the case of proton beams, the RBE is assumed to have a constant value of 1.1 and for carbon ion beams the RBE has to be evaluated and optimized in the planning

procedure. All of these models rely on the linear–quadratic model of cell survival. The linear–quadratic model, however, has limitations, especially at high doses.

Also in the development of short-ranged alpha-emitters, the RBE has to be determined, as the consensus value of 5 does not cover all exposures. The mean absorbed dose is not always the most ideal biomarker for damage. Small scale dosimetry models are of great value to differentiate the effects by short-ranged α-particle emitters from external or high energy β-particle emitters. Radiobiology in nuclear medicine therapy is more than the physics of absorbed dose rate and dose distributions. The non-uniformity of radioactivity uptake at cellular scale triggers depending on the particle range many different biological response and repair processes. The radiobiology of these processes is very different from what is commonly known from external beam exposures.

Key Words
Relative Biological Effect (RBE), Linear-Quadratic model, Ion beam radiotherapy, alpha-particles, radiobiology, radiopharmaceutical therapy, low dose rate