Time for radiobiology in the nuclear medicine community

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Radiobiology is the science of the interaction of ionizing radiations with living tissues. To begin with we have been unaware of the potential hazard resulting from the exposure to ionizing radiations and for decades no health control or physical measurement of absorbed dose has been put into practice for exposed medical staff. Following the observation that ionizing radiations may have harmful effects, radiobiology has lived a period of great interest, culminating with the study of atomic bomb survivors and, more recently, with the Chernobyl accident. Modern radiobiology focuses on two major subjects: development of radiobiological models for the optimization of therapies using high doses of ionizing radiations and assessment of risk in the field of low doses.

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Radiobiology of high doses of ionizing radiations

In recent years radionuclide therapy (RNT) has been increasingly used and this has prompted us to elaborate models to predict toxicity and efficacy of treatment. A treatment planning approach to RNT more and more will eventually require incorporation of radiobiological considerations of therapeutic radiopharmaceuticals [1, 2]. The development of radiobiological models for treatment planning, however, is still at an early stage of development as compared to external beam radiotherapy (EBRT). To date, most radiobiological models of RNT have been based on the extrapolation of data obtained following homogeneous exposures to acute single or fractionated doses of EBRT and have assumed that EBRT and RNT administered doses have biological equivalence.

Several differences exist, however, between RNT and EBRT: in RNT the radiation dose is delivered to the tumour cells by continuous, but declining, exposure with a low dose rate (LDR) that is a function of the initial uptake, cellular distribution, residence time, radionuclide half-life and energy. The average dose rate for RNT is typically of the order of 2–8 Gy/day, and the maximum absorbed dose may be up to 50 Gy delivered over a period of many days. This is in marked contrast to the situation with EBRT, where the dose is delivered at a constant high dose rate (HDR), typically 1–5 Gy/min [3].

Emerging evidence suggests that the mechanisms by which cells respond to LDR radiation exposures are fundamentally different from those occurring at HDR with EBRT [1, 4]. The combination of prolonged response, limited toxicity and the ability to treat on multiple occasions suggests that the mechanism of action of LDR

therapies is different from that seen with HDR exposures. Accordingly, treatment plans, clinical trials and outcome measures should be designed to take this difference into account. Current radiobiological research points to a way in which RNT can be more effectively administered to patients by taking into account the biology of the tumour, the mechanism of action of the therapy as well as the physical characteristics of the radionuclide [3].

Several groups throughout Europe are active in the field, as documented by the increasing number of presentations on the subject at recent European Association of Nuclear Medicine (EANM) congresses.

Radiobiology of low doses of ionizing radiations

There is also growing interest in radiobiology for the assessment of radiation-induced risk, especially in the field of diagnostic, low doses [5]. The effect, however, of low doses of ionizing radiation (<100 mSv) is still a matter of debate [6]. Although several epidemiological data suggest that current estimates of risk are grossly overestimated in nuclear medicine, no clear demonstration of this has ever been obtained [7, 8]. The European Commission, however, is worried that the exposure to low doses of radiation, as in the case of diagnostic imaging, might not be as harmless as thought so far and is promoting research in the low dose field to assess the entity of the risk.

The European Commission promoted the creation of the High Level Expert Group (HLEG) on European Low Dose Risk Research with the aim of identifying critical areas for research in the field of low dose radiation. The HLEG has identified the main fields requiring further research and in particular: ‘shape of dose-response curve for cancer’, ‘individual radiation sensitivity for cancer’ and ‘non-cancer effects’, ‘radiation quality’, ‘tissue sensitivity’ and ‘internal emitters’. The HLEG, in the attempt to boost the scientific programme, promoted the formation of the Multidisciplinary European Low Dose Initiative (MELODI) platform (<http://www.melodi-online.eu>).

On 18–20 October 2010, the second international workshop of the MELODI platform was held in Paris, France. The workshop was attended by over 200 participants from all over Europe and was open to all interested researchers in the field. Participants were divided into different groups to discuss the needs in the specific area of interest. The workshop had the aim to develop a successful strategic research agenda (SRA) in Europe for low dose research, including nuclear medicine, and to describe the roadmap for medium-term scientific research goals. The nuclear medicine community, however, was not repre-

sented at the workshop. We know that nuclear medicine is different and it is important that specific research projects are promoted to address and clarify the different radiation risks associated with the use of X and gamma rays. The next MELODI workshop will be held in Rome from the 2nd to 4th of November 2011. We invite everybody involved in radiobiology in our nuclear medicine community to participate in the congress so that we can bring our point of view and be an active component in the planning of the SRA in the field of low dose radiation.

We believe that radiobiology is an important component of modern nuclear medicine and plays a relevant role in everyday practice. The Italian Association of Nuclear Medicine (AIMN) has recently created the Study Group of Radiobiology with the aim of addressing several critical issues, such as radiation risk, optimization of radionuclide therapies, radioprotection of patients and staff, use of radioprotectors and others. In an attempt to raise the awareness of the nuclear medicine community and to promote new lines of research in the field, we are organizing an international congress “From dosimetry to biological effect: radiobiology as a guide to clinical practice in nuclear medicine” that will be held in Sorrento (Naples) from the 5th to the 8th of November 2011 (<http://www.nuclearmedicinediscovery.org>). At the end of the congress, a practical course on biological dosimetry will be organized that will help all interested groups to harmonize the techniques to be used in multicentre studies.

There is, however, a need for a concerted action at the European level to promote and coordinate different lines of research. The EANM might consider the opportunity of creating a task group in radiobiology to address these points; this would give our association also an official body that might discuss important issues with other institutions, such as MELODI, WHO and the International Atomic Energy Agency (IAEA) amongst others. We hope to further discuss this within the EANM in order to organize under their patronage continuing medical education (CME) sessions or other focused events.

We are living in a time of change in our field, and nuclear medicine should not miss the opportunity to be an active part of it.

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