Dosimetric improvements for selective internal radiation therapy of hepatic tumours and impact on patient response

Lead Institute: Imagerie et Vision Artificielle (ImViA – https://imvia.u-bourgogne.fr/en/home-page), EA 7535, Université de Bourgogne, Dijon, France. The ImViA laboratory, counting about a hundred researchers, is located in Dijon. Its research activities are centered around three teams: CORES (artificial vision), IFTIM (clinical imaging) and VIBOT (vision for robotics).

Specific Units:
ImViA – IFTIM: the objectives of the IFTIM team are focused on two core fields in clinical imaging: deployment of new imaging markers for preclinical and then clinical aspects combined with the development of new applications. The second field is processing and analysis of medical images.
Department of Nuclear Medicine, Centre Georges-François Leclerc (CGFL), Dijon, France: CGFL is a leading clinical and research center dedicated to cancer treatment, member of UNICANCER federation.

Duration of studentship: Three years starting in October/November 2020

Stipend: About 1500 € net per month

Main supervisor: Jean-Louis Alberini, Nuclear Medicine Doctor - PhD

Other members of the supervisory team: Romain Popoff, Medical Physicist - PhD, Benoit Presles, Image Processing Researcher - PhD

KEYWORDS: Dosimetry; SIRT; 90Y; MAA; Deep Learning; GATE simulation; Nuclear Medicine; Image Processing, Medical Physics.

CONTEXT

Liver cancer is the sixth most common cancer in the world but the second leading cause of cancer mortality in men. Among the different types of liver cancer, some can be treated by selective internal radiation therapy (SIRT), which consists in injecting Yttrium-90 (90Y) β-emitter microspheres into the liver. This project aims at improving SIRT treatments by bringing **state-of-the-art dosimetric techniques to SIRT** that will be validated through **Monte-Carlo simulations**, and developing **deep learning methods to predict treatment response** from previous dosimetric models.
The 90Y microspheres injection treatment has multiple steps. An acquisition of magnetic resonance imaging (MRI) is performed, followed by a simulation of the treatment via a technetium-99m macroaggregated albumin (Tc99m-MAA) single-photon emission computed tomography (SPECT)/CT scan. This SPECT/CT scan leads to compute a pre-treatment dosimetry and allows to determine the amount of 90Y microspheres needed for the treatment. Right after the injection of 90Y microspheres, a positron emission tomography (PET)/CT scan is acquired to compute a 90Y-treatment dosimetry. This dosimetry should be as accurate as possible to document the actual dose delivered to the targets in SIRT. Besides, there is increasing evidence of a dose-effect relationship in the case of SIRT. However, dosimetric results are known to be very sensitive to technical factors (acquisition, reconstruction, segmentation, dosimetric models) and, in the absence of standardised techniques, a bunch of dosimetric thresholds has been reported in the literature. Until recently, most of the dosimetry models have been carried out using empiric formulae or simplified dosimetric models.

OBJECTIVES

The first aim of this work is to validate a more accurate dosimetric model for both the Tc99m-MAA-pre-treatment and the 90Y-post-treatment by using a Monte-Carlo approach with the GATE toolkit. This validation implies simulations of physical phantoms representative of the liver uptake in SIRT and comparisons with state-of-the-art techniques such as the voxelized dosimetry used in clinical routine.
Based on the data collected since 2012, **the second aim of this work** is to develop a supervised deep learning classification approach to predict the treatment response using either the Tc99-MAA-pretreatment dosimetry or the 90Y-treatment dosimetry or both and assess correlations from our validated dosimetric calculations.

SKILLS REQUIRED
Candidates must hold at least an **upper second class degree or equivalent** qualifications in a relevant subject area such as physics, biomedical engineering, computer science, or applied mathematics to apply to this **interdisciplinary project** with clinicians, IT specialists, and medical physicists. **A master's degree** in a relevant discipline and additional research experience would be an advantage.

APPLICATIONS
CV and covering letter outlining your motivation for the position should be sent to:
Jean-Louis Alberini: jean-louis.alberini@u-bourgogne.fr;
Romain Popoff: rpopoff@cgfl.fr;
Benoit Presles: benoit.presles@u-bourgogne.fr.

Informal enquiries should be addressed to Jean-Louis Alberini, Romain Popoff, and Benoit Presles.

RECRUITMENT STEPS
→ 22nd of May 2020: application deadline

→ 2nd of June 2020: invitation for an interview of the selected candidates

→ 11th & 12th of June 2020: interview of the selected candidates

→ Early July 2020: results notification to the interviewed candidates