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The role of advanced dose calculation methods in modern brachytherapy techniques

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Radiation therapy is used in the treatment of almost 50% of all cancers in industrialized countries. Over the years, advances in engineering, computer technology, material sciences and biology has enabled medical physicists to devise more accurate radiation delivery systems. One of the oldest forms of radiation therapy is brachytherapy, or originally called Curiethérapie in honor of Marie Curie. In brachytherapy one or more radiation sources are placed within or in close proximity of the tumor mass, thus spearing more easily normal tissues and limiting irradiation to a small area of the body. While medical imaging has been central to the new generation of brachytherapy systems currently available, it is but one of many enablers. In this presentation, we will underline the increasing role that advanced dose calculation methods, in particular the Monte Carlo, are playing in developing the next generation of treatments for cancer patients. This includes the design of new sources, the extraction of their dosimetric characteristics, the development of new applicators and better treatment planning and dose optimization algorithms. Looking forward, the Monte Carlo method will likely be central to the safe and accurate deployment of targeted therapies based on a combination of radioisotopes and nanomaterials. It could further play an important role in modeling the interaction physics, and ensuing chemical processes, of radiation with DNA and other cellular structures.

Author: BEAULIEU, Luc (Université Laval)

Presenter: BEAULIEU, Luc (Université Laval)

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