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Update on the NanOx biophysical model: Current status and perspectives

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Improving our understanding of radiation effects at different spatial and time scales is a crucial step towards the optimization of cancer treatments based on innovative and re-emerging radiotherapies.
To this end, predictive tools known as biophysical models are built starting from fundamental physical, chemical and biological quantities. The PHABIO group at the IP2I of Lyon has been working over the last years in the development of the biophysical model NanOx. As distinguishing features, the model takes into account the full stochasticity of radiation interactions and the role of reactive chemical species to induce damage through oxidative stress. While NanOx was first conceived for computing the biological dose in hadrontherapy treatments, recent efforts have lead to its extension for adapting it to irradiations with low-energy ions, which play an important role in promising targeted radiotherapies. On the side of hadrontherapy, the model has been successfully benchmarked against in vitro experimental data for several cell lines, showing a better performance when compared to other biophysical models. Moreover, the coupling of NanOx with GATE, an open-source Monte Carlo simulation toolkit, has facilitated the use of the model to compute biological outcomes at the voxel level under realistic irradiation conditions with carbon and helium ions. On the side of targeted radiotherapies, preliminary tumor control probability (TCP) results have been obtained in the context of targeted radionuclide therapy with alpha-particles (TAT), considering the impact of the intracellular distribution of the radionuclides. The purpose of this work is to present the current status of the NanOx model, its latest applications and future perspectives.

Auteur principal: ALCOCER AVILA, Mario (IP2I, Lyon)

Orateur: ALCOCER AVILA, Mario (IP2I, Lyon)

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