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RT basics - physics perspective

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Radiation is being used for cancer therapy for well over 100 years and due to this long history it is sometimes claimed, it is an old fashioned and outdated form of medicine. Radiation therapy is, however, still around and more vital than ever. The main reason is probably, that radiotherapy is based on physical principles and consequently has always been benefitting from technological progress. Radiation therapy is currently the only treatment modality, which allows for a precise calibration of the treatment device, a mathematical description of the dose to the patient in three dimensions, the possibility to verify that dose in phantoms prior to delivery and in addition to predict outcome based on biophysical models. The mathematical formulation of the whole treatment process and prediction of probabilities for a certain clinical outcome make it unique and offer many possibilities for further improvement. Starting already with the development of Cobalt units, the concept of dose conformation to the target was pursued, which again is based on radiobiological concepts. This line was followed by the introduction of high energy X-rays and later on particle beams, which further improve the dose conformation and today the problem of three-dimensional dose conformation can considered to be solved technically. The next step –following a physical slang –is now to achieve conformality in the 4th dimension, meaning to conform the dose to the target not only in space, but in time. This is done by treatment adaption and makes use of recent developments in radiological imaging technology. For the first time in radiotherapy, it is now possible to use magnetic resonance imaging to continuously visualize the target region, while the treatment is being delivered. This is a dramatic shift of paradigms for radiotherapy and will certainly have an enormous impact on the way radiotherapy is delivered. In addition, the advances in understanding the interactions of radiation with the human body, e.g. with the immune system and based on the specific genome of a tumor, open further options to optimize the use of radiotherapy and arrive with a personalized treatment. In this talk the most important physics principles and developments will be addressed and the connections to the radiobiological and clinical aspects will be outlined.

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