Mathematical models improve the quality and efficacy of radiotherapy

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Radiotherapy, in which radioactive radiation is used to damage cancer cells, is a common cancer treatment. However, the people applying the treatment are only human and there are other uncertainties involved in it. On March 31st, Marleen Balvert will be defending her PhD thesis in which she shows that these risk scan be reduced using mathematical optimization models.

Because radiation can penetrate healthy tissue, radiotherapy is eminently suitable for the treatment of deep-seated tumors that are difficult to get at for surgeons because of the surrounding tissue. Unfortunately, it is impossible to prevent that a certain amount of radiation will affect the surrounding tissue. However, the radiation dose that reaches these organs can be reduced by, among other things, choosing the right positions from which radiation is applied, the intensity of the radiation, and the duration of the radiation. Mathematical models can help doctors find the right balance between the quality of the treatment plan in terms of high doses for the tumor and low doses to surrounding tissue.

Uncertainties in treatment plans

In making a treatment plan, uncertainties cannot be avoided. A plan is made on the basis of a body scan in which the exact locations of the tumor and the healthy tissue are difficult to pinpoint. The true position of the tumor or a healthy organ can deviate slightly from the position the doctor has observed in the scan. As a result, the radiation dose that reaches the tumor can be too low. To reduce the risks a mathematical model has been developed in which these uncertainties are incorporated. The model includes all possible locations of the tumor and the healthy organs, and yields a treatment plan that in the worst-case scenario offers the best treatment possible.

Reducing the risk of too low doses

The new optimization model has been developed for brachytheraphy, a treatment in which tiny radioactive sources are inserted into the tumor and irradiate the tumor from within. The model has been tested with data from six prostate cancer patients. The results show that in comparison to the currently utilized clinical method the new planning model reduces the risks of getting too low doses in the tumor. Further research with data from a larger group of patients is required to substantiate these results.

Provided by Tilburg University

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