Towards artificial intelligence-based automated planning in clinical practice: a prospective study of the first clinical experiences in high-dose-rate prostate brachytherapy

Danique L.J. Barten, Bradley R. Pieters, Anton Bouter, Marjolein C. van der Meer, Stef C. Maree, Karel A. Hinnen, Henrike Westerveld, Peter A. N. Bosman, Tanja Alderliesten, Niek van Wieringen, Arjan Bel.

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What was your motivation for initiating this study?

Due to scientific collaboration with the evolutionary intelligence research group at the Centrum Wiskunde & Informatica (CWI; Centre of Mathematics and Computer Science, a national research institute in Amsterdam, The Netherlands), and business partner Elekta, we were able to develop an algorithm based on artificial intelligence (AI), which finds multiple treatment plans that illustrate the best trade-off between irradiating the tumour and sparing the surrounding healthy tissues. During a retrospective observer study, the algorithm performed excellently and the automated plans were accepted by the physicians. Therefore, we chose to make it ready for clinical use for high-dose-rate (HDR) prostate brachytherapy and called it BRIGHT (**br**achytherapy via artificially **i**ntelligent **G**OMEA-**h**euristic-based **t**reatment planning).

In several studies, automatic planning had been examined retrospectively, but its use had not been evaluated in clinical practice. Moreover, there was no reported experience of the application of AI algorithms in brachytherapy. That is why we were particularly interested to find out whether our AI-based algorithm fulfilled our expectations in clinical practice and what we could learn from the clinical implementation of AI. Moreover, since AI-based treatment planning is not standard practice yet in brachytherapy, we believed it was important to share our experiences of this transition from research and development to clinical practice.

What were the main challenges during the work?

Despite the publication of promising results in the literature, the idea remains that automated planning, which includes AI algorithms, is challenging to implement in clinical practice and might meet resistance.

There were several challenges in the design of this study and the interpretation of the results. One was the measurements of the times for each process step, such as correctly recording 'the time for plan selection' and the influence of avoidable process delays. Further explanation was often given during the treatment plan selection, for example to residents. In addition, we had to deal with understaffing and training of new staff, which meant that the learning curve changed during the study.

The next challenge was to present our data clearly and in a way that was easy for readers to interpret. We took advantage of the opportunity to explore our experience and additional challenges, and to provide accounts of these in such a way that not only we, but also the brachytherapy community, could learn from them.

What are the most important findings of your study?

Our AI-based plan optimisation for HDR prostate brachytherapy is feasible for use in clinical practice and fulfils the expectation that it would add value. One of the fulfilled expectations was that the use of BRIGHT would provide several possible plans for the treatment of a particular patient, which would include options for the sparing of specific healthy tissues. So, its use frees time to be spent on carefully choosing the desired plan, instead of adjusting one plan iteratively.

In addition, the study confirmed that the physician made use of patient-specific information, experience and general knowledge that was not, or could not be, captured in dose-volume criteria. This finding showed that the trade-off curve of possible treatment plans did add value.

At the same time, our clinical experience has provided additional information about how BRIGHT could be improved, such as the addition of dose-volume criteria that would reduce the number of undesired high-dose areas.

What are the implications of this research?

There is potential to use the AI-based algorithm more widely. In the meantime, a follow-up project has been started with the CWI and Leiden University Medical Center, through a grant from the Dutch Cancer Society and business partner Elekta, in which the treatment software is expanded to cover other cancer types and target areas, starting with cervical cancer. In addition, the software should be validated at a national level in other hospitals. It would be nice if other institutes, both high- and low-volume centres, could benefit from the use of this algorithm in the future.

Danique L. J. Barten, MSc.
Amsterdam UMC
Department of Radiation Oncology
University of Amsterdam

Meibergdreef 9, 1105 AZ Amsterdam
The Netherlands
Phone: +31 20 7327826
email: d.l.j.barten@amsterdamumc.nl