

Automation of Treatment Planning Process for IMRT Prostate cases

P Kapoor^{1,2},

¹ Virginia Commonwealth University, Richmond, Virginia

² Hunter Holmes McGuire VA Medical Center, Richmond, Virginia

INTRODUCTION

Treatment planning with IMRT technique for prostate cancer though appears simple but takes up considerable amount of time for the planners to create a good plan. There is a fair amount of consistency in the achievable dose coverage but a planner may approach the task with different planning techniques.

AIM

To introduce a solution that standardizes and improves the technique, quality and efficiency for IMRT prostate treatment planning.
Our goal is to create a workflow for a one-click planning process.

METHOD

In order to be efficient and consistent with our treatment planning process, Pinnacle TPS scripts are developed in-house to automate the treatment planning technique for prostate. Multiple steps are involved with achieving this goal.

Standardization of structure names and dose constraints - The first step was to standardize the structure names and dose constraints and fractionation scheme. Prior to developing the treatment planning scripts, standardization of structure nomenclature has been implemented as per AAPM-TG-263 recommendations with the help of pinnacle scripts for the prostate diseases site. The dose fractionation scheme was also standardized as per the phase 3 CHHiP trial (hypo-fractionated IMRT for prostate cancer).

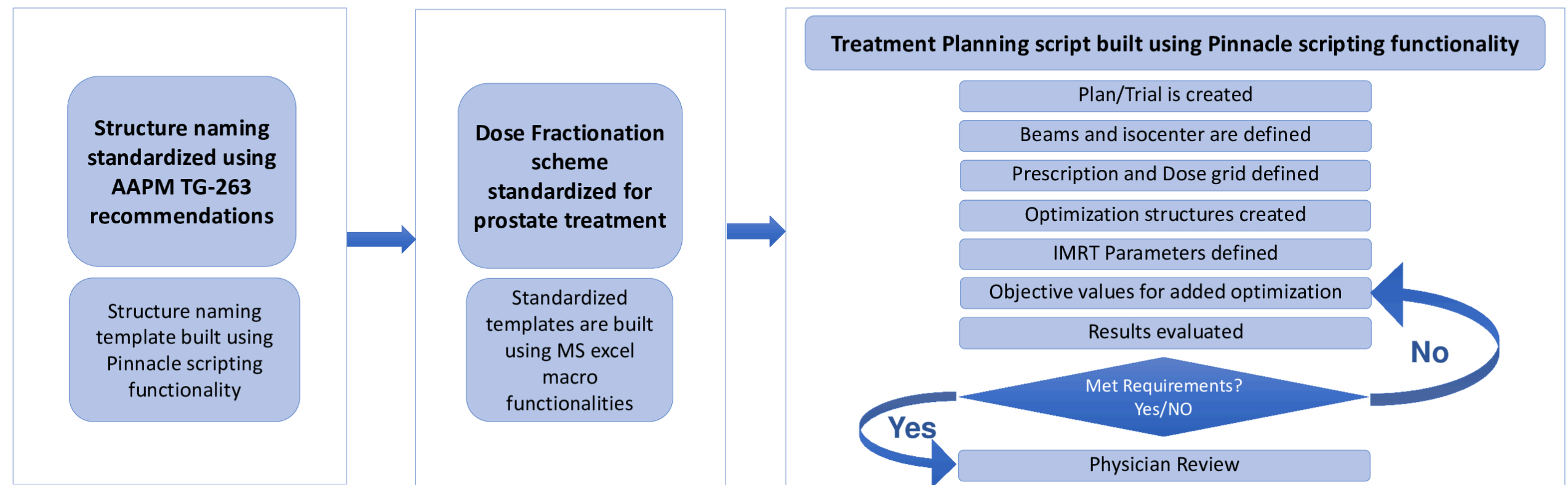
Treatment Planning script - Standardizing nomenclature laid the foundation for building scripts for automated treatment planning using Pinnacle v9.8's scripting library. A good planning technique uses non-conflicting constraints; rings-structures to confine 50% dose-spillage; hotspots inside the PTV, etc. to improve plan quality and reduce monitor-units (MUs). The script is intended to automate the steps that are performed manually by the planner such as defining beam-angles, plan name, dose-grid, prescription, creating optimization structures, optimization objectives and parameters, etc. To test the value of the automated method over the manual method, 10 plans each were evaluated and total MUs; average time spent by the planner were compared.

Mathematically, the cost function of the optimization gave good results when the objective functions are non-competing. Keeping this principle in mind, the use of overlapping OARs is avoided during optimization, instead Boolean operations are used by the script to create new structures to limit the dose to OARs. The technique uses 4-5 ring structures to conform the dose around PTV and avoid hotspots outside the target volumes.

RESULTS

In most cases, the first optimization provides promising results and no further intervention is required from the planner's end to improve the plan. The optimization technique used in the script provides the optimal results..

The use of automated script reduced the number of re-plans from 20% to 1%. The average time spent by the planner was reduced by approx. 50-70%. The use of scripts for treatment planning has improved our plan-quality and reduced the total MUs per plan. The inter-user variability in planning technique is minimal and we are able to achieve consistent dose distribution. The t-test showed a statistically significant difference in MUs between the automated and manual method (p-value=0.00402).



CONCLUSIONS

Standardization is key to improve efficiency and helps to automate workflow and processes in a busy clinic. Implementing scripting tools in our workflow proved to be very successful in achieving improved plan quality and reduced variability in dose distributions among planners.

Utilization of a automation script, with its associated time saving and integrated process management, can quickly and automatically generate an acceptable clinical treatment plan for prostate cancer with either improved or similar results compared to a manually created plan.

We expect that the design is extensible to other anatomical sites and we plan to explore that in future work.

REFERENCES

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CONTACT INFORMATION

Priyanka Kapoor, MS, DABR
Virginia Commonwealth University
Email: priyanka.kapoor@vcuhealth.org