To Tweak or Not to Tweak? Prospects for Daily Online Adaptation Using Unedited CBCT Auto-Segmentation

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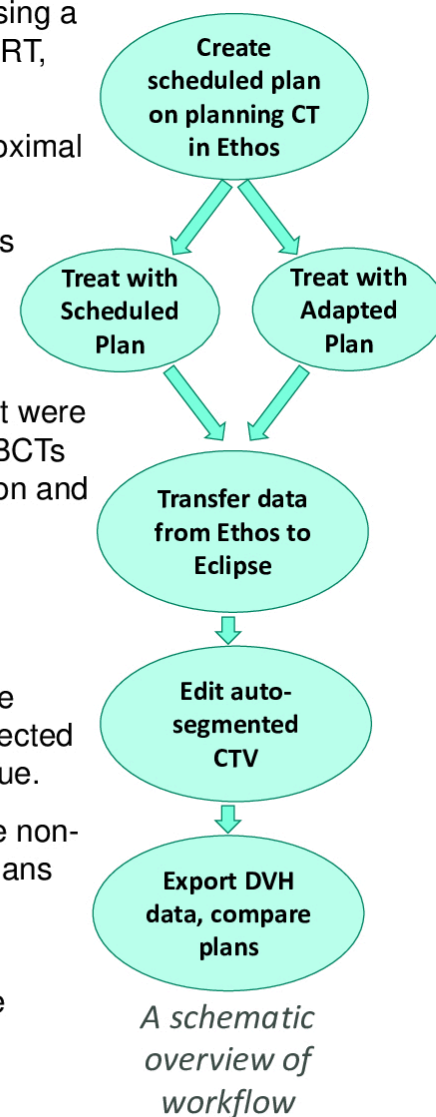UC San Diego Health

RETHINKING MEDICAL PHYSICS

INTRODUCTION

New technologies facilitating online adaptive radiation therapy (ART) are becoming more widely available, but the time-consuming nature of clinician-driven target contour editing at the treatment machine limits the numbers of patients who could benefit from this technology.

The purpose of this study was to evaluate the impact of daily online ART without manual contour edits on prostate target coverage using the Varian Ethos™ adaptive workflow with built-in auto-segmentation and auto-planning on CBCT images.

METHOD

- Planning CTs from 25 retrospective prostate patients were re-planned using a Varian Ethos™ emulator, 12-field IMRT, and 2Gy fractions.

- CTV included intact prostate and proximal seminal vesicles.

- Our clinical asymmetric PTV margins were used: 3mm posterior, 5mm left/right/anterior, and 7mm superior/inferior.

- The first 10 fractions for each patient were adapted using their daily iterative CBCTs and the emulator's auto-segmentation and auto-planning workflow without any manual contouring edits (CTVauto).

- The dose distribution and auto-segmentation was exported to our treatment planning system where the CTVauto contour was reviewed/corrected by human experts to create a CTVtrue.

- CTV coverage was evaluated for the non-adapted (scheduled) and adapted plans on CTVtrue.

- This analysis was repeated for a full course of radiotherapy for two single patients to examine intra-patient variability.
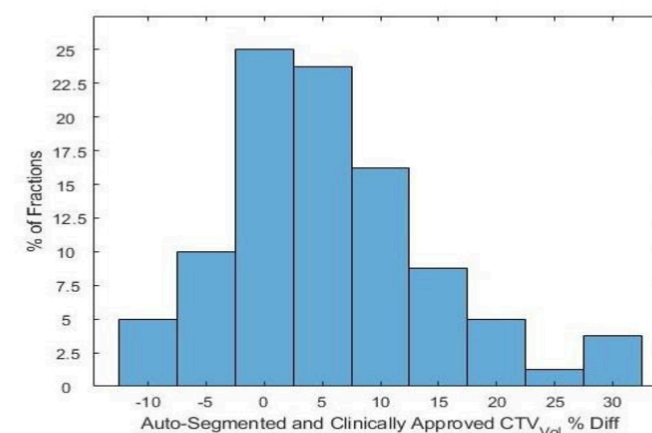
Create scheduled plan on planning CT in Ethos

Treat with Scheduled Plan

Treat with Adapted Plan

Transfer data from Ethos to Eclipse

Edit auto-segmented CTV

Export DVH data, compare plans

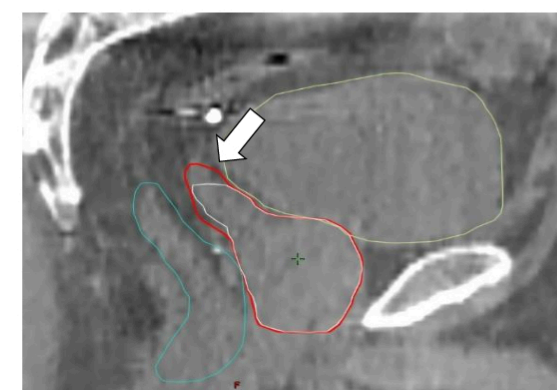*A schematic overview of workflow*

RESULTS

- **Without adaptation, CTV_{true} D_{min} was greater than 95% for only 46% of fractions; fully-automated adaptation nearly doubled this to 84%.**

- CTV_{true} D_{min} increased for 74% and 100% of fractions with fully-automated adaptation for two patients treated for 27 fractions

- A majority (224/250) of daily CTV_{auto} contours required some editing to obtain CTV_{true}

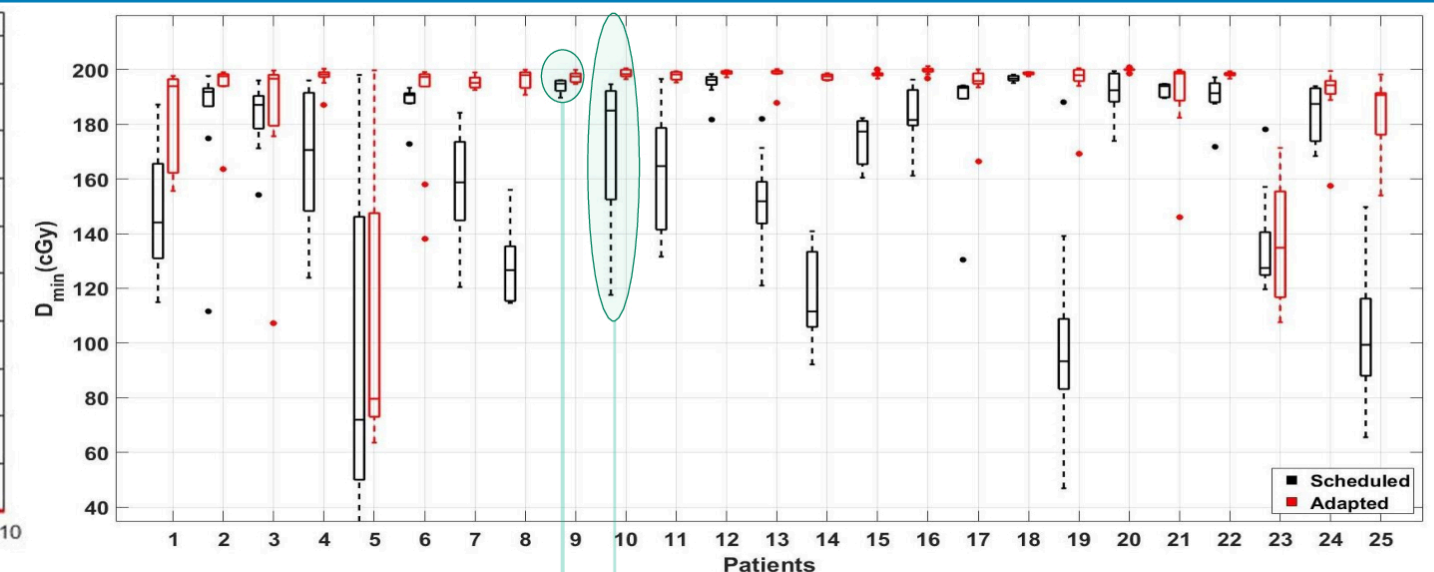- Contour edits focused on the seminal vesicles with the prostate generally accurately auto-segmented.
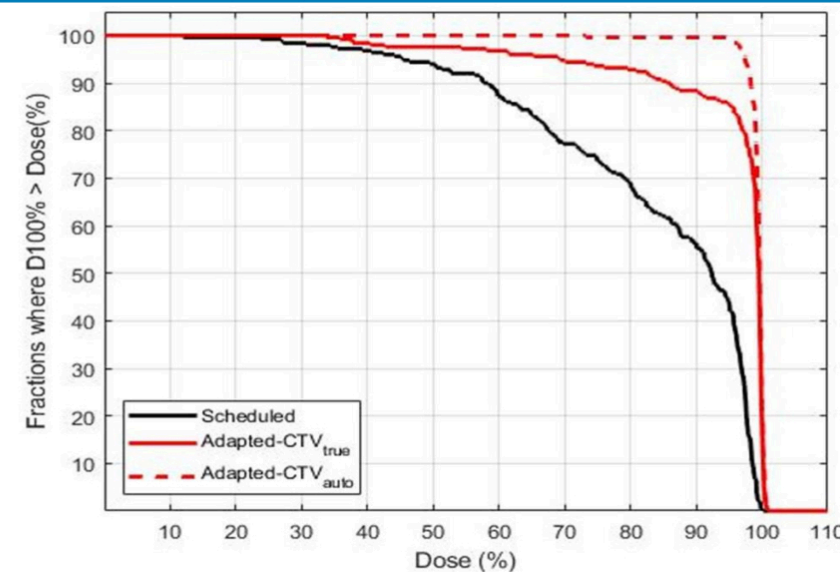
Fraction of treatments where CTV D_{min} > different dose thresholds with/without adaptation and/or CTV edits. Daily adaptation without manual contour edits at the machine (red line) doubled the number of fractions where CTV Dmin>95% compared to not adapting (black line). Editing the contours at treatment (dashed red line) can further increase this to 100% of all fractions but requires a longer treatment timeslot.


Interpatient variability in increase of D_{min} with/without adaptation. Figure shows the D_{min} values for the 10 treated fractions per patient evaluated on the CTV_{true} contour using the scheduled (black) versus adapted plans (red). All 25 patients would have benefited from adaptation but the amount of impact varied between patients.

%ΔVol between auto-segmented CTV_{auto} and clinically approved CTV_{true}.

Auto-segmented CTV (red) vs edited CTV (white). Majority of edits were in seminal vesicles.
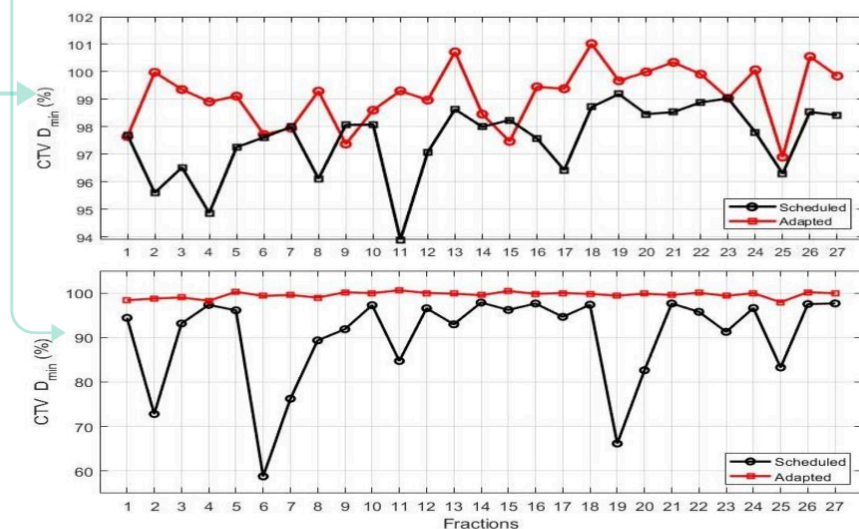
Intrapatient variability. Comparison of CTV_{true} D_{min} for all 27 fractions for two patients. Adapting without manual edits increased the CTV D_{min} for 74% of fractions in one case, and 100% of fractions for the other one.

CONCLUSIONS

Online daily adaptation using Ethos can double the fractions of prostate treatments where CTV Dmin>=95% suggesting the Ethos daily adaptive workflow is superior to existing non-adapted workflows even without expert contour review/correction.

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CONTACT INFORMATION

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