



# Rapidplan: 'knowledge-based' model with Tomotherapy plans

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### Inverse Planning Variability:

1. Dependent on Planner's skill
2. Balancing clinical objectives
3. Iterative process that can be time consuming

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Pract Radiat Oncol. 2012 Oct-Dec;2(4):296-305.

Variation in external beam treatment plan quality: An inter-institutional study of planners and planning systems.

Nelms BE1, Robinson G2, Markham J2, Velasco K2, Boyd S2, Narayan S2, Wheeler J3, Sobczak ML4.

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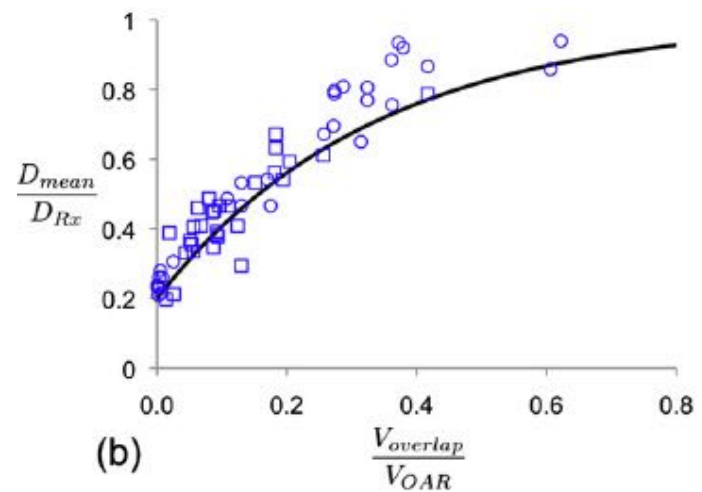
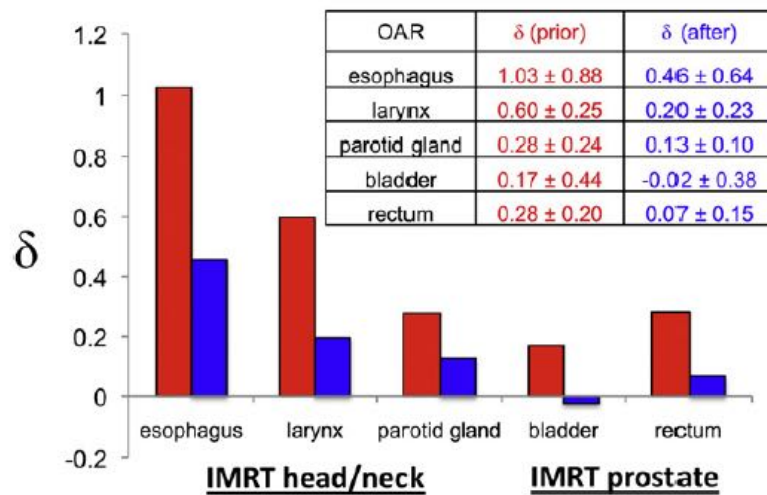
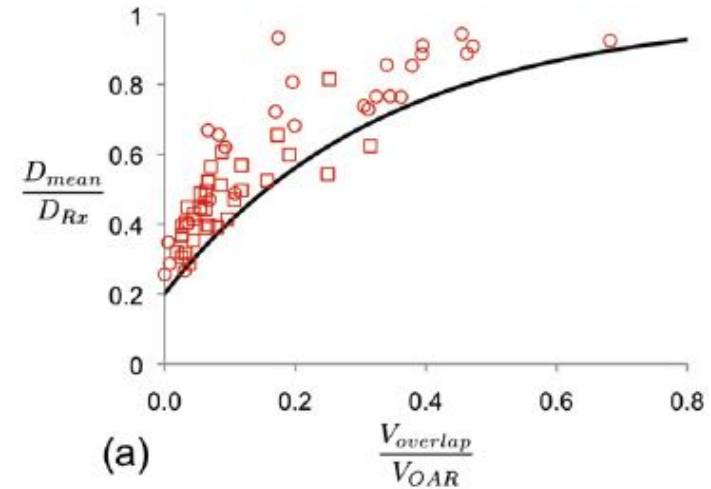
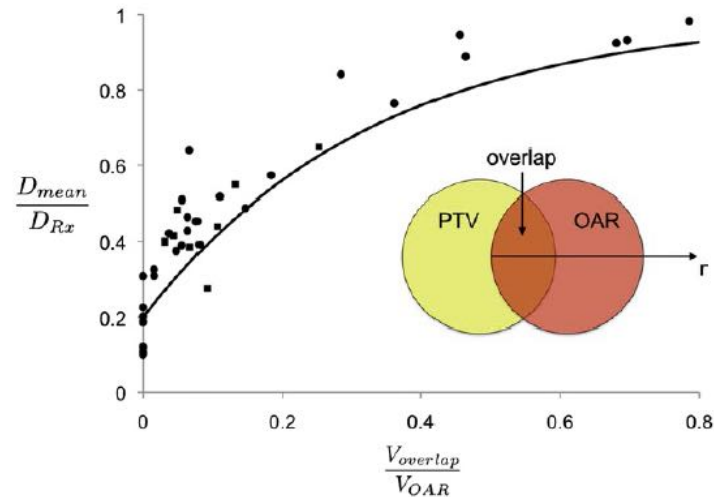
*...CONCLUSIONS: The ability of the treatment planners to meet the specified plan objectives (as quantified by the PQM) exhibited no statistical dependence on technologic parameters (TPS, modality, plan complexity), nor was the plan quality statistically different based on planner demographics (years of experience, confidence, certification, and education). Therefore, the wide variation in plan quality could be attributed to a general "planner skill" category that would lend itself to processes of continual improvement where best practices could be derived and disseminated to improve the mean quality and minimize the variation in any population of treatment planners.*

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# Knowledge-Based MODEL: WHY?

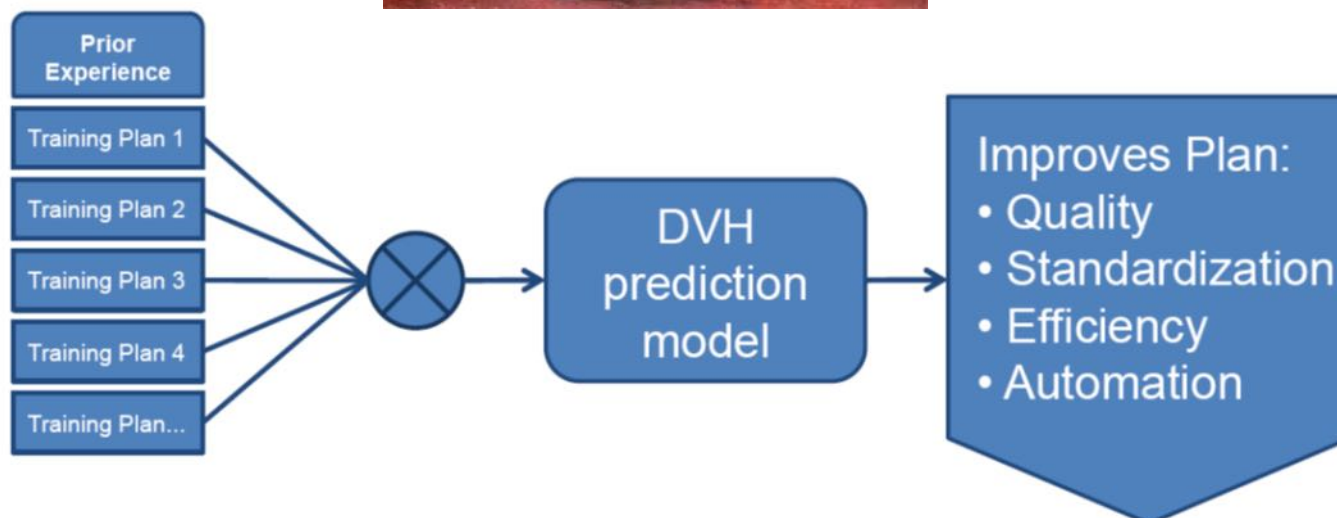
## EXPERIENCE-BASED QUALITY CONTROL OF CLINICAL INTENSITY-MODULATED RADIOTHERAPY PLANNING

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# Knowledge-Based MODEL

## Technique A

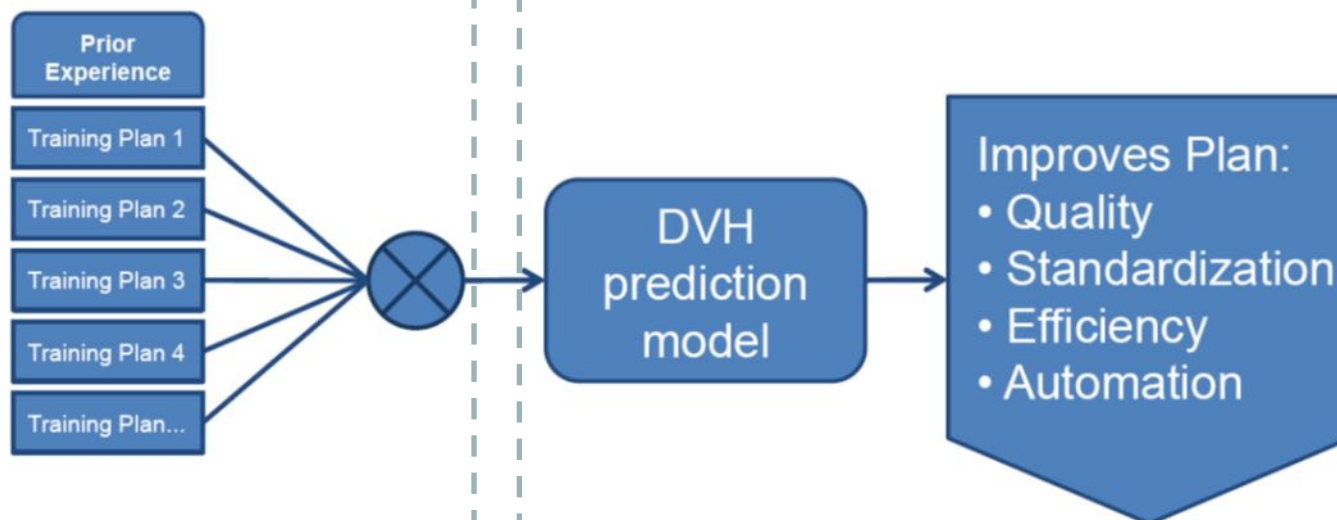


# PURPOSE: KBP possible application

## Hi Art HT



## TB VMAT



One possible application could be to use KB models based on plans of consolidated technique, in order to supply the lack of planning experience with a new treatment technique

# METHODS: Knowledge-Based Planning system RapidPlan™

## Varian's Solution for Knowledge-Based Planning

DVH Estimation Model

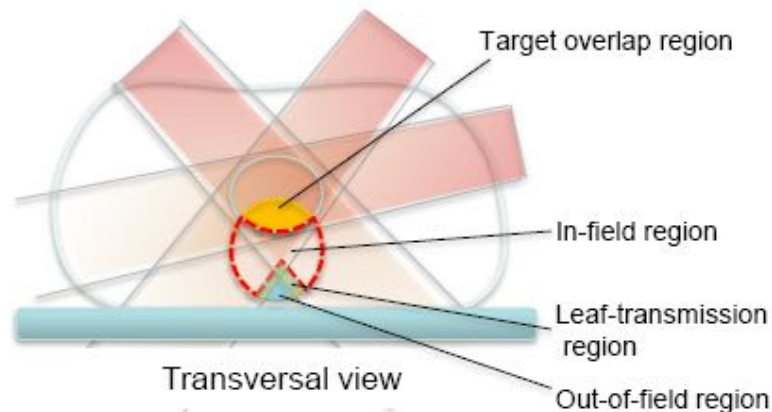
Tumor Site Specific

Trained from existing plans that have accepted OAR tradeoffs

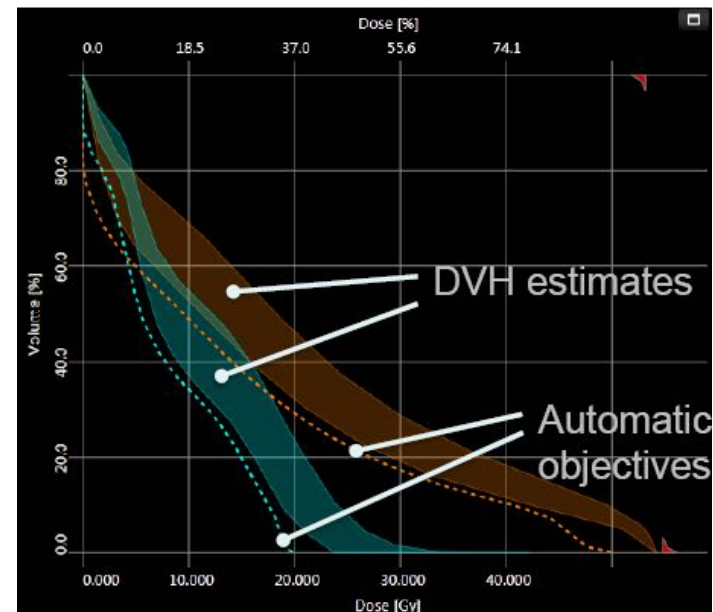
Uses principal component analysis for each OAR

Different sub-volumes use different DVH estimation

Automatic objective generation



Different out-of-field/in-field/ leaf-transmission and target overlap volumes



## METHODS: The input dataset - Model configurations – Model validation

65 HT plans of patients presenting prostate cancer were selected for train 2 models:

35 plans → Low Risk Model (LR )

30 plans → Intermediate Risk Model (IR)

Treatments in 28 fractions (hypofractionation):

prostate: 70.0 Gy (2.5 Gy/fx)

vesicle: 56 Gy (2 Gy/fx) – only for IR

Contour and dose validation performed by one radiation oncologist in order to prevent outliers.

65 HT dose distributions were linked to 65 RapidArc plans on TPS Eclipse

RapidArc technique: 2 arcs, 6MV, HD-MLC, 30°/330° complementary collimator angle

2 evaluation groups, consisting of 5 new knowledge based plans (KBP) each, were used to validate LR and IR models. KBPs were compared with the clinical plans (CP) in term of PTVs homogeneity, using  $HI = 100 \times (D2\% - D98\%) / D50\%$ , and DVH endpoints

# Model validation

## Organs at risk trained in the Model:

Rectum	(65 matched)
Bladder	(65 matched)
Femoral H L/R	(65 matched)

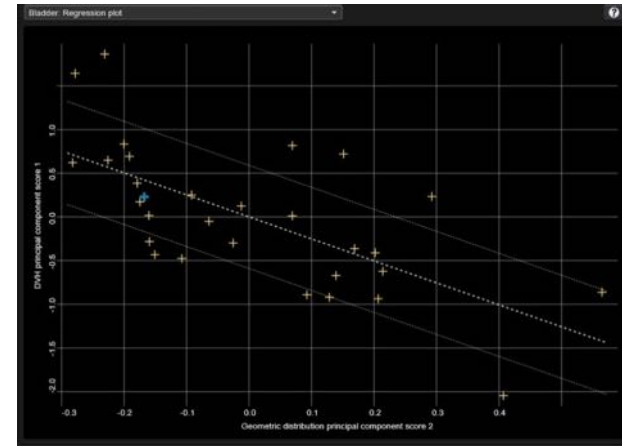
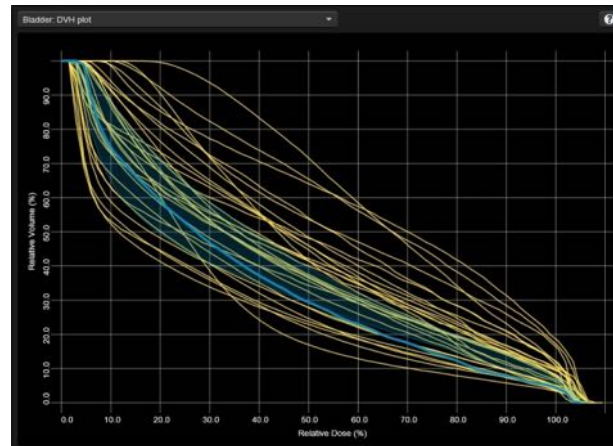
## Targets in the Model:

PTV_prostate	(65 matched)
PTV_vesicle	(30 matched)

### Bladder (IR- Model)

$$\chi^2 = 1.115$$

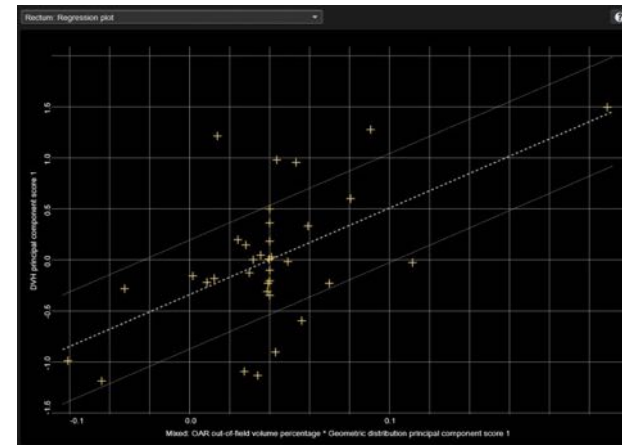
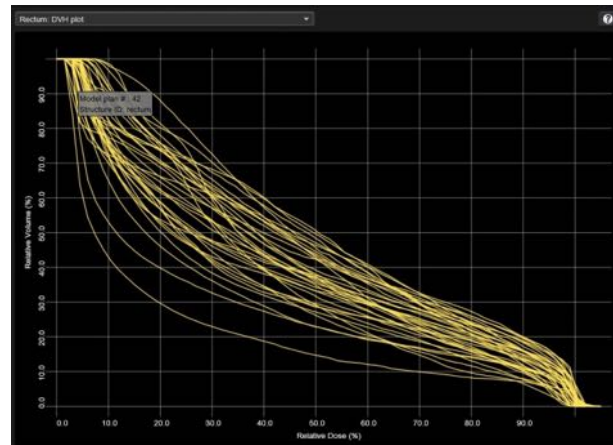
$$R^2 = 0.648$$



### Rectum (LR- Model)

$$\chi^2 = 1.186$$

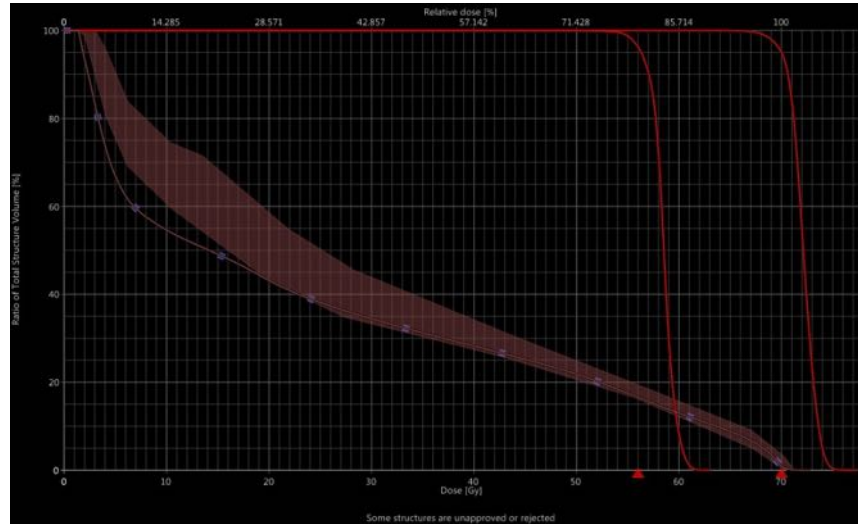
$$R^2 = 0.516$$



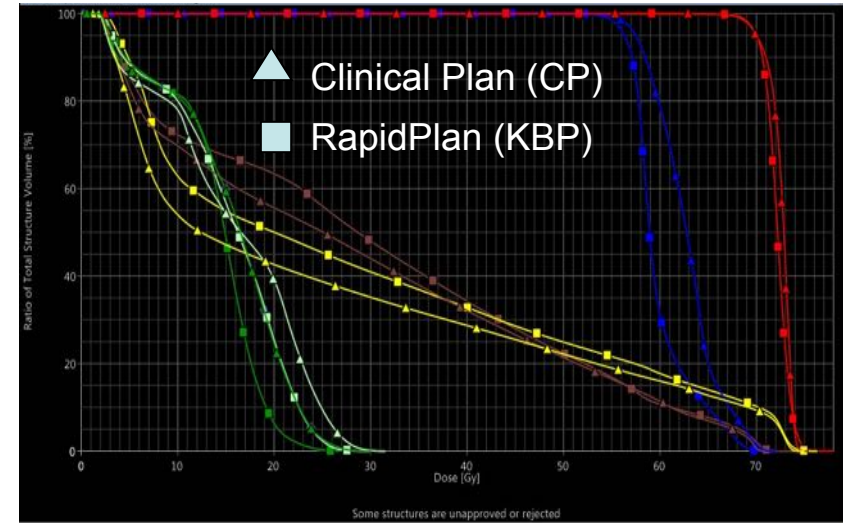


# RESULTS

An example of the estimated DVH bounds



An example of plan comparison: KBP vs CP



Structures	DVH endpoints	LR	IR
PTVp	HI [%]	-1.3 [-3.2, 1.2]	1.0 [-3.5, 3.2]
PTVv			-3.3 [-6.2, 2.2]
Rectum	V <sub>60</sub> [%]	1.0 [-3.5, 5.2]	-0.7 [-4.1, 4.2]
	V <sub>65</sub> [%]	0.9 [-1.4, 3.3]	0.8 [-2.9, 3.2]
	V <sub>70</sub> [%]	0.5 [-1.0, 1.2]	1.4 [-1.1, 0.8]
Bladder	V <sub>60</sub> [%]	1.2 [-2.1, 3.1]	1.8 [-2.0, 3.2]
	V <sub>70</sub> [%]	0.5 [-1.5, 2.2]	0.2 [-1.0, 2.4]
Right femur	D <sub>max</sub> [Gy]	-1,3 [-2.5, 1.2]	-0.8 [-3.3, 1.8]
Left femur	D <sub>max</sub> [Gy]	-2.0 [-4.5, 2.2]	-0.6 [-3.5, 1.5]

Average differences between test and original plans (KBP-CL). Ranges [in parenthesis] are indicated

## CONCLUSIONS

The study was carried out for prostate cancer patients

The KBP dose-volume constraints, generated by HT based models, were suitable for the RA optimization process

The 2 models were effective to suggest optimization objectives consistent with the criteria set by an expert RA planner

Preliminary results of the quantitative comparison analysis between CP and KBP do not evidence any substantial differences between the benchmark and the test plans