Knowledge-based Plan Quality Feedback Report for FASTRACK-RENAL

Patient Identifier: 15.03_1503-051
Report prepared on: 7/8/2019 12:00:00 AM

Dosimetric Analysis Summary:

Structure	Variations	KBP feedback statement
PTV	All dose metrics are acceptable	Dose metrics are unlikely to be improved further
ITV	All dose metrics are acceptable	Dose metrics are unlikely to be improved further
SmallBowel	Dose metrics have major variations	Plan could be improved to be within acceptable variation
Skin	All dose metrics are acceptable	Some dose metrics could likely be improved
SpCord	All dose metrics are acceptable	Dose metrics are unlikely to be improved further
LargeBowel	All dose metrics are acceptable	Some dose metrics could likely be improved
Stomach	All dose metrics are acceptable	Dose metrics are unlikely to be improved further
Kidney_I	All dose metrics are acceptable	Dose metrics are unlikely to be improved further
Kidney_C	All dose metrics are acceptable	Dose metrics are unlikely to be improved further
Liver	All dose metrics are acceptable	Dose metrics are unlikely to be improved further

Please review the subsequent pages of this report for individual structure DVH analysis and comparison to the knowledge-based planning reference for this patient. These should be interpreted primarily as verification that the plan quality submitted is similar to how previous patients treated to this protocol have been planned. This process is aimed at reducing outliers in plan quality. Differences between KBP and the submitted plans are presented; for OARs where KBP is greater than 10% lower than the submitted plan, this is highlighted. Where differences exist between KBP and the submitted plan, it is entirely up to your clinical judgement to determine whether the improvement would be clinically beneficial for the patient. This includes taking into account trade-offs that may have been made between different organs which may have led to differences between the KBP and submitted plans. Details of how the model has been built, frequently asked questions and references regarding the basis for KBP can be found at the end of this report.

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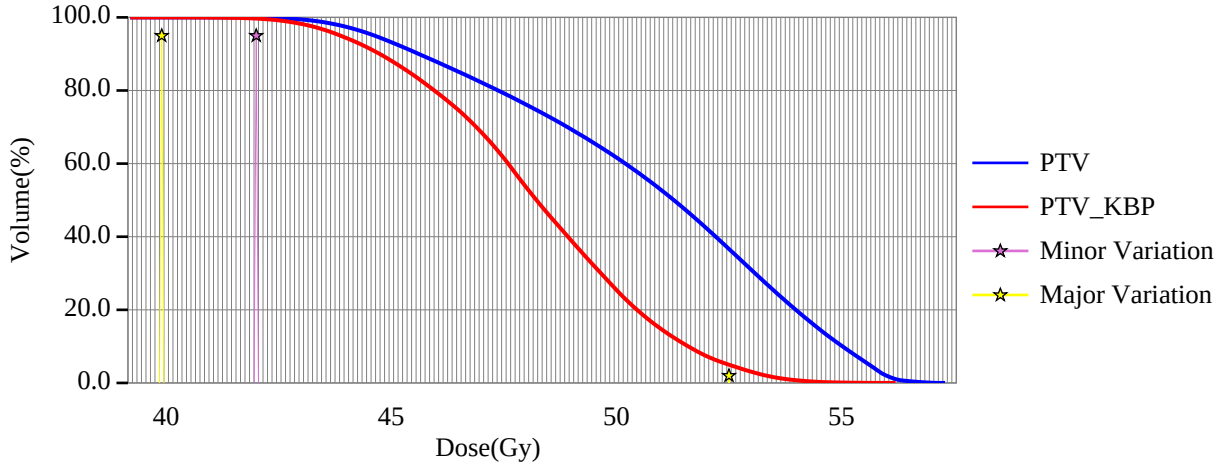
PTV Report



Structure: PTV					
Volume(cm3): 127.15, Equivalent Diameter(cm): 6.24					
Dosimetric Parameter	**Submitted Plan**	**Minor Variation**	**Major Variation**	**KBP Plan**	**KBP Feedback**
D95%(Gy)	44.63	>=41.958	>=39.9	43.87	Plan has no minor variation and is unlikely to be improved further
D99%(Gy)	43.32	-	-	42.62	
DMEAN(Gy)	50.75	-	-	48.22	
DMAX(Gy)	57.21	>=60.06	>=52.5	56.18	Plan has minor variation but is unlikely to be improved further
D50%(Gy)	51.28	-	-	48.22	
D2%(Gy)	56	-	-	53.33	
D0.03cc(Gy)	57.07	-	>=52.5	55.54	Plan has no minor variation and is unlikely to be improved further

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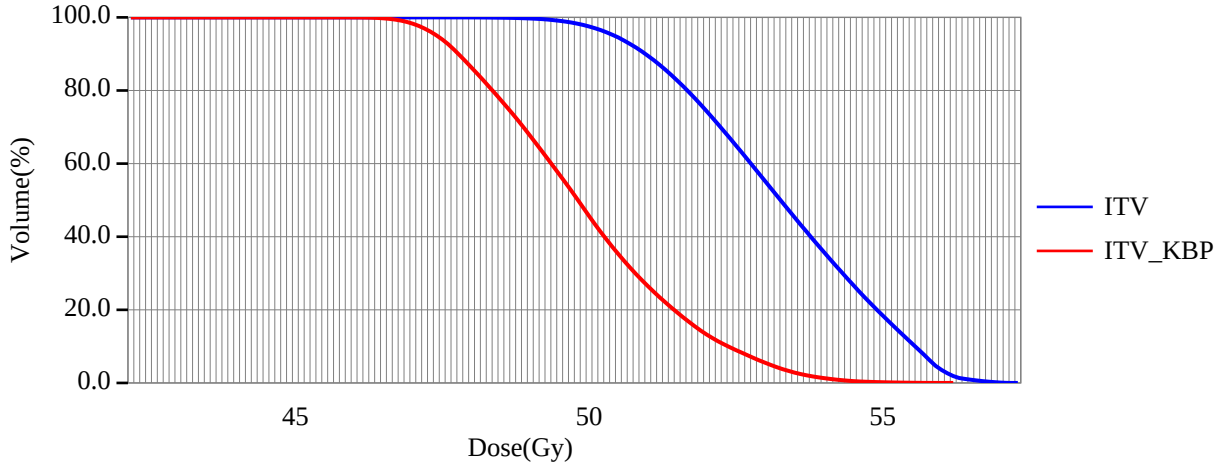
ITV Report



Structure: ITV					
Volume(cm3): 70.49, Equivalent Diameter(cm): 5.13					
Dosimetric Parameter	**Submitted Plan**	**Minor Variation**	**Major Variation**	**KBP Plan**	**KBP Feedback**
D99%(Gy)	**49.52**	**-**	**-**	**46.83**	
D0.03cc(Gy)	**57.07**	**-**	**-**	**55.54**	

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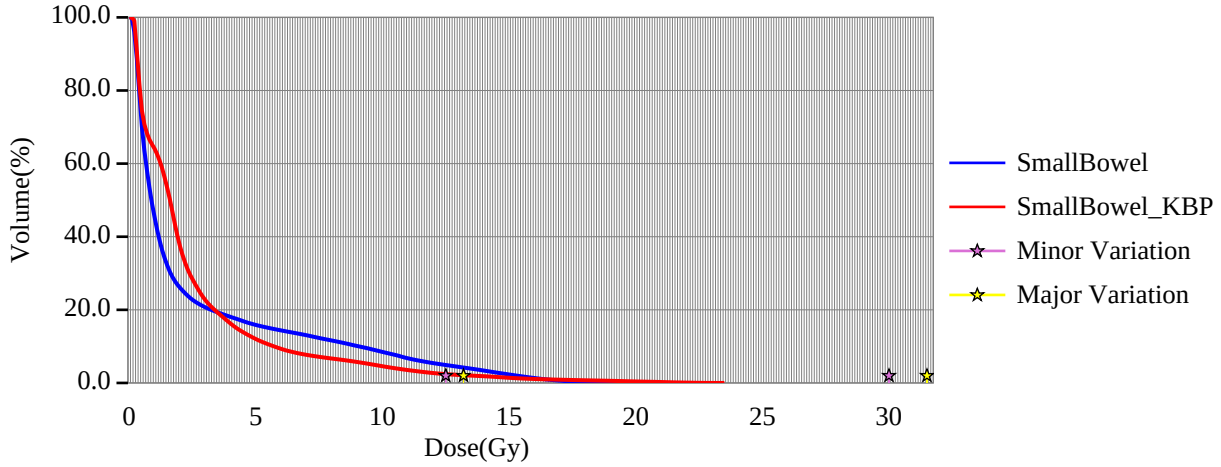
Small Bowel Report



Structure: SmallBowel					
Volume(cm3): 1041.84, Equivalent Diameter(cm): 12.578					
Dosimetric Parameter	**Submitted Plan**	**Minor Variation**	**Major Variation**	**KBP Plan**	**KBP Feedback**
D0.03cc(Gy)	**19.26**	**<=30**	**<=31.5**	**23.11**	**Plan has no minor variation and is unlikely to be improved further**
D30cc(Gy)	**14.46**	**<=12.5**	**<=13.2**	**11.77**	**Plan has major variation but could likely be improved to have no major variation**

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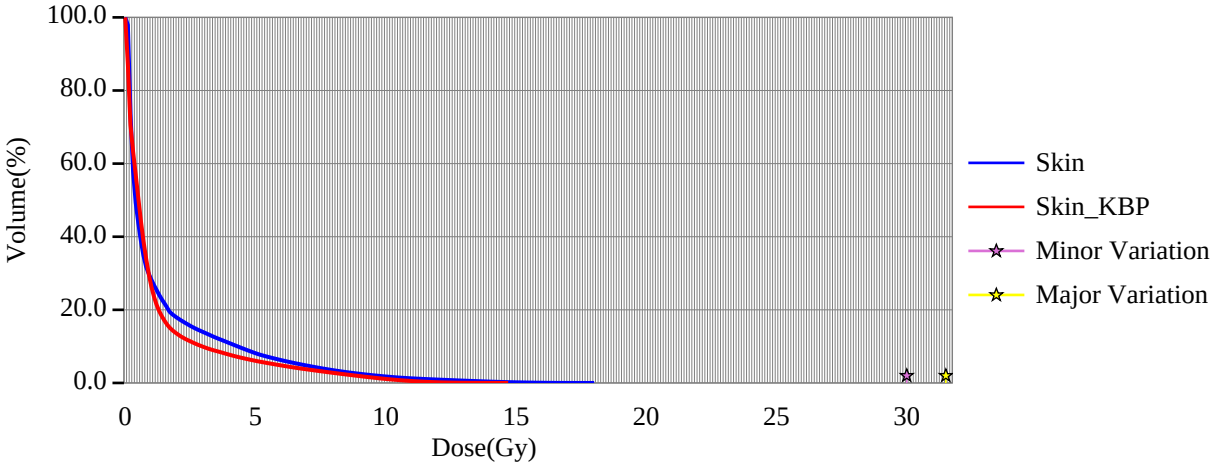
Skin Report



Structure: Skin					
Volume(cm3): 630.84, Equivalent Diameter(cm): 10.641					
Dosimetric Parameter	**Submitted Plan**	**Minor Variation**	**Major Variation**	**KBP Plan**	**KBP Feedback**
D1.5cc(Gy)	**14.59**	**<=30**	**<=31.5**	**11.78**	**Plan has no minor variation but could likely be improved further**

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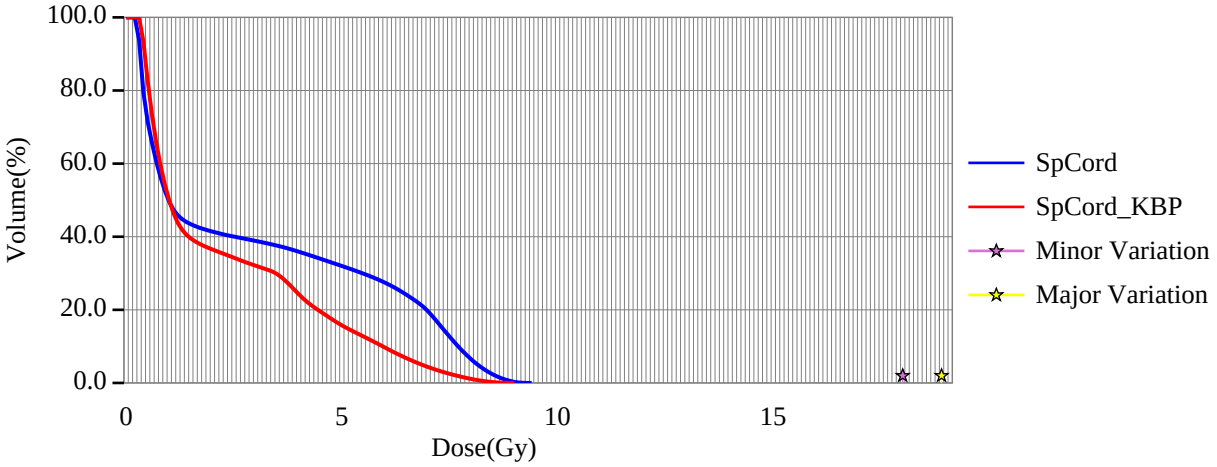
Spinal Canal Report



Structure: SpCord					
Volume(cm3): 40.36, Equivalent Diameter(cm): 4.256					
Dosimetric Parameter	**Submitted Plan**	**Minor Variation**	**Major Variation**	**KBP Plan**	**KBP Feedback**
D0.03cc(Gy)	**9.13**	**<=18**	**<=18.9**	**8.69**	**Plan has no minor variation and is unlikely to be improved further**

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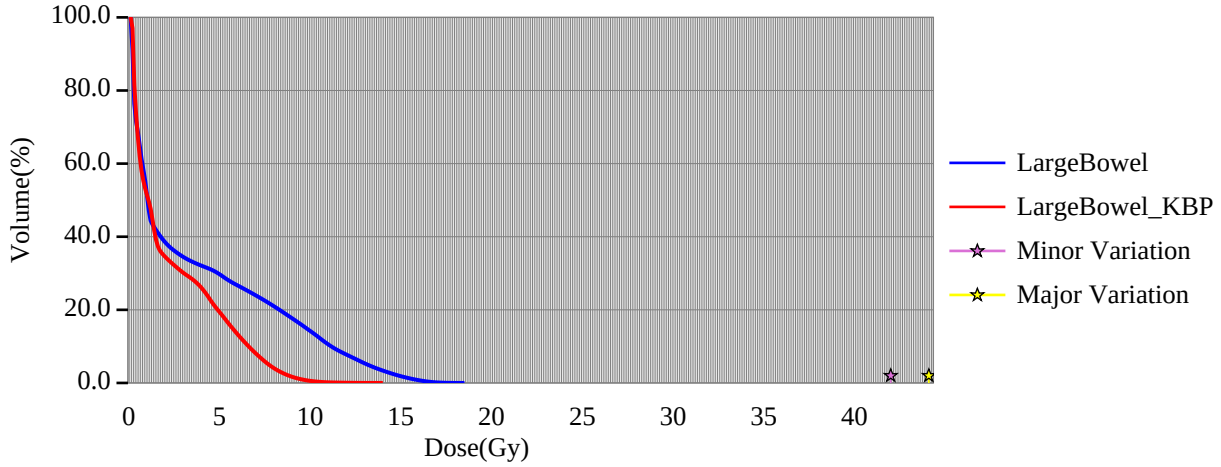
Large Bowel Report



Structure: LargeBowel					
Volume(cm3): 672.9, Equivalent Diameter(cm): 10.872					
Dosimetric Parameter	**Submitted Plan**	**Minor Variation**	**Major Variation**	**KBP Plan**	**KBP Feedback**
D1.5cc(Gy)	**16.75**	**<=42**	**<=44.1**	**10.74**	**Plan has no minor variation but could likely be improved further**

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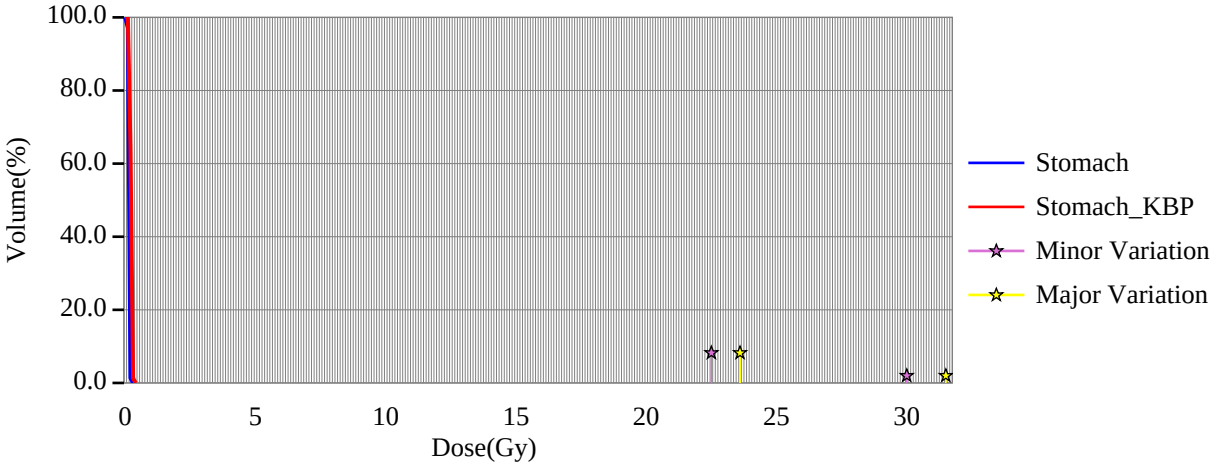
Stomach Report



Structure: Stomach					
Volume(cm3): 60.71, Equivalent Diameter(cm): 4.876					
Dosimetric Parameter	**Submitted Plan**	**Minor Variation**	**Major Variation**	**KBP Plan**	**KBP Feedback**
D0.03cc(Gy)	**0.22**	**<=30**	**<=31.5**	**0.31**	**Plan has no minor variation and is unlikely to be improved further**
D5cc(Gy)	**0.17**	**<=22.5**	**<=23.6**	**0.28**	**Plan has no minor variation and is unlikely to be improved further**

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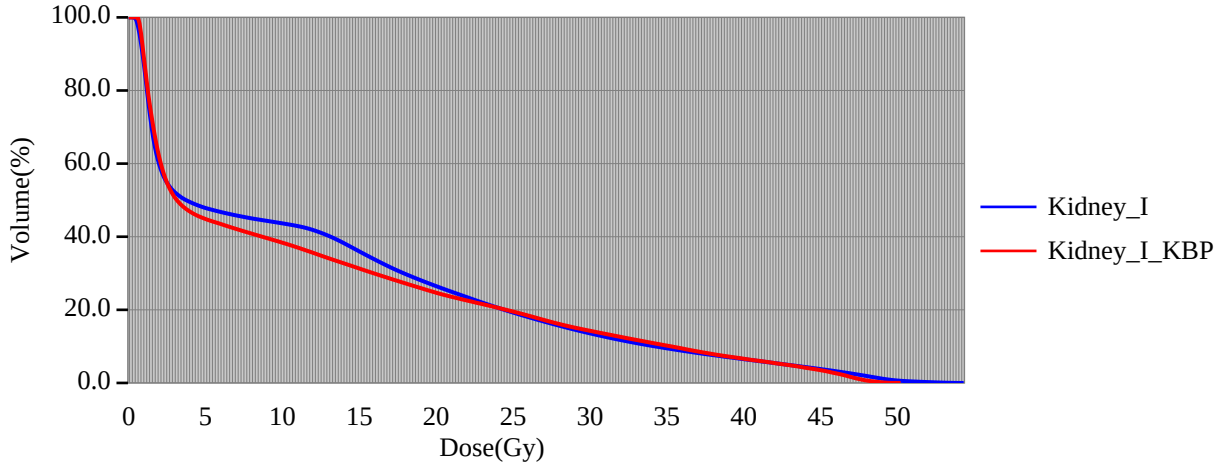
Ipsilateral Kidney Report



Structure: Kidney_I					
Volume(cm3): 228.28, Equivalent Diameter(cm): 7.583					
Dosimetric Parameter	**Submitted Plan**	**Minor Variation**	**Major Variation**	**KBP Plan**	**KBP Feedback**
D1.5cc(Gy)	**50**	**-**	**-**	**48**	
V10Gy(%)	**43.65**	**-**	**-**	**38.35**	
V21Gy(%)	**24.93**	**-**	**-**	**23.55**	

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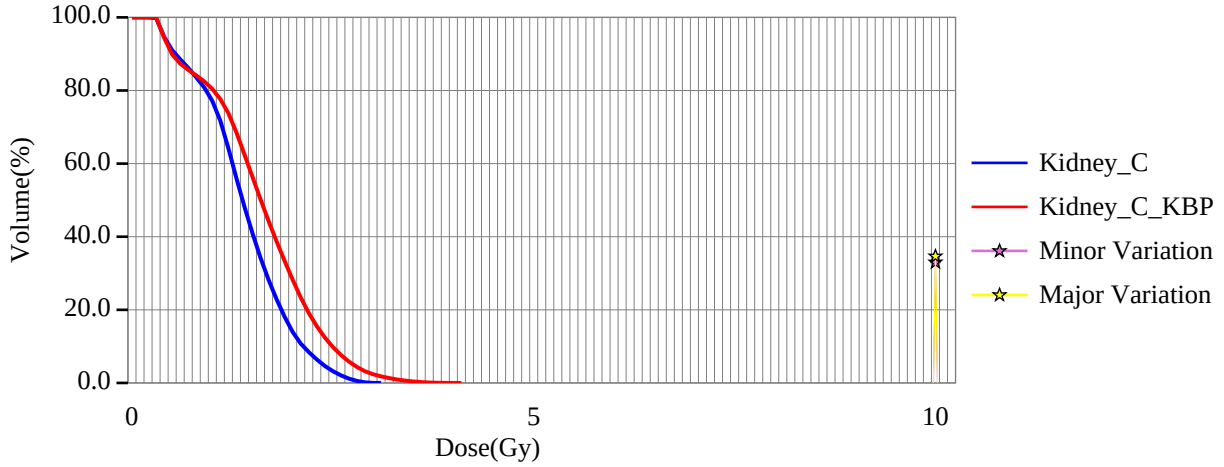
Contralateral Kidney Report



Structure: Kidney_C					
Volume(cm3): 277.34, Equivalent Diameter(cm): 8.091					
Dosimetric Parameter	**Submitted Plan**	**Minor Variation**	**Major Variation**	**KBP Plan**	**KBP Feedback**
V10Gy(%)	**0**	**<=33**	**<=34.65**	**0**	**Plan has no minor variation and is unlikely to be improved further**
D0.03cc(Gy)	**2.99**	**-**	**-**	**3.9**	

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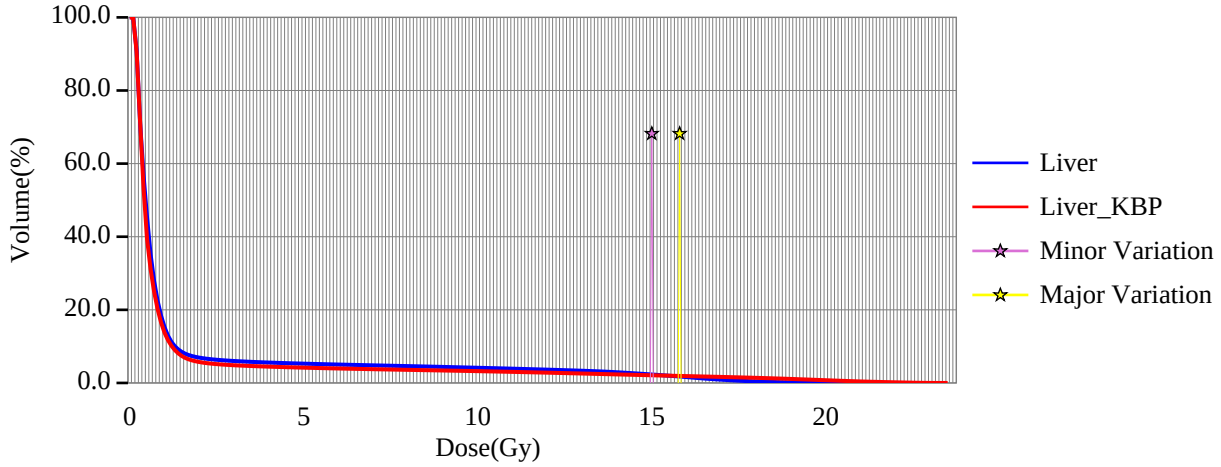
Liver Report



Structure: Liver					
Volume(cm3): 1026.19, Equivalent Diameter(cm): 12.514					
Dosimetric Parameter	**Submitted Plan**	**Minor Variation**	**Major Variation**	**KBP Plan**	**KBP Feedback**
D700cc(Gy)	**0.32**	**<=15**	**<=15.8**	**0.32**	**Plan has no minor variation and is unlikely to be improved further**
D0.03cc(Gy)	**20.53**	**-**	**-**	**23.18**	

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Objectives used in KBP plan:

KBP plan Objectives					
Structure	**Type**	**Limit**	**Volume(%)**	**Dose(Gy)**	**Priority**
PTV-ITV	Point	Lower	100.00	42.00	100
PTV-ITV	Point	Upper	0.00	46.20	43.147298
SmallBowel_prox	Point	Upper	0.00	25.20	66.249627
SmallBowel_prox	Line	Upper	-	-	66.249627
Stomach	Line	Upper	-	-	100
SpCord	Point	Upper	0.00	14.70	83.828984
SpCord	Line	Upper	-	-	83.828984
Skin	Point	Upper	0.00	21.00	100
Skin	Line	Upper	-	-	100
Liver	Line	Upper	-	-	100
LargeBowel	Line	Upper	-	-	69.583238
Kidney_I	Line	Upper	-	-	70.457626
Kidney_C	Line	Upper	-	-	70.883217
ITV	Point	Lower	100.00	46.20	100
ITV	Point	Upper	0.00	54.60	46.146964

Frequently Asked Questions

1. How is the KBP reference plan generated?

   Knowledge-based planning is accomplished by collecting samples of previously treated patients and training predictive models that yield accurate predictions of final plan dosimetry based on individual patient anatomy[1-4]. These predictions are then used to inform inverse optimization by automatically generating patient-specific optimization objectives.

2. What technical parameters were used for the KBP plans?

   The knowledge-based plans were developed in Varian's RapidPlan using dose-volume estimation models trained with multi-arc volumetric-modulated arc (VMAT) plans on C-arm linear accelerators. The KBP reference plan presented in this report was developed in the same treatment planning system and represents a deliverable plan on a VMAT-capable Varian linear accelerator (15MV photons, 120-leaf Millenium MLCs).

3. How are the knowledge-based feedback statements generated?

   The language behind the KBP feedback statements associated with each plan quality metric are obtained from the following table for normal tissue structures:

Variable Definitions
Ds = Soft Constraint
Dh = Hard Constraint
Dplan = Submitted plan value
Dkpb = KBP value

Scenario	Analysis	KBP scenario	KBP feedback statement
Dplan <= Ds	Meets Soft Constraint	Dplan <= Dkbp	Plan meets soft constraint and is unlikely to be improved further
		Dkbp < Dplan	Plan meets soft constraints but this dose metric could likely be improved further
Ds < Dplan <= Dh	Exceeds Soft Constraint	Dplan <= Dkbp	Plan exceeds soft constraint but this dose metric is unlikely to be improved further
		Ds < Dkbp < Dplan	Plan exceeds soft constraint but this dose metric could likely be improved further
		Dkbp <= Ds < Dplan	Plan meets soft constraint but this dose metric could likely be improved to meet soft constraint
Dplan > Dh	Exceeds hard Constraint	Dplan <= Dkbp	Plan exceeds hard constraint but this dose metric is unlikely to be improved further
		Dh < Dkbp < Dplan	Plan exceeds hard constraint but this dose could likely be improved further
		Dkbp <= Dh < Dplan	Plan exceeds hard constraint but this dose metric could likely be improved to meeth hard constraint

An equivalent table is used for target coverage metrics with the "less than" inequalities converted to "greater than" conditions.

5. I cannot make my re-plan meet every element of the KBP reference plan, what should I do?

The KBP plan represents a deliverable plan according to the planning parameters specified in #2. More often than not, highly similar plans should be attainable. However, depending on treatment planning system and/or machine delivery configuration, an exactly equivalent plan might be difficult or even impossible to achieve. Participating sites are encouraged to use their clinical judgment and practical time constraints in regards to the effort put forth to match the KBP reference plans.

References:

1. Zhu X *et al.,* A planning quality evaluation tool for prostate adaptive IMRT based on machine learning. *Medical Physics.* Feb 2011;38(2):719-726.

2. Appenzoller LM *et al.,* Predicting dose-volume histograms for organs-at-risk in IMRT planning. *Medical Physics.* 2012;39(12):7446.

3. Moore KL *et al.*, Quantifying Unnecessary Normal Tissue Complication Risks due to Suboptimal Planning: A Secondary Study of RTOG 0126. *International Journal of Radiation Oncology* Biology* Physics.* 2015;92(2):228-235.

4. Li N *et al.*, Validation of a Knowledge Based Automated Planning System in Cervical Cancer As a Clinical Trial Quality System, Annual Meeting of the American Society for Radiation Oncology, San Antonio, TX (2015)