

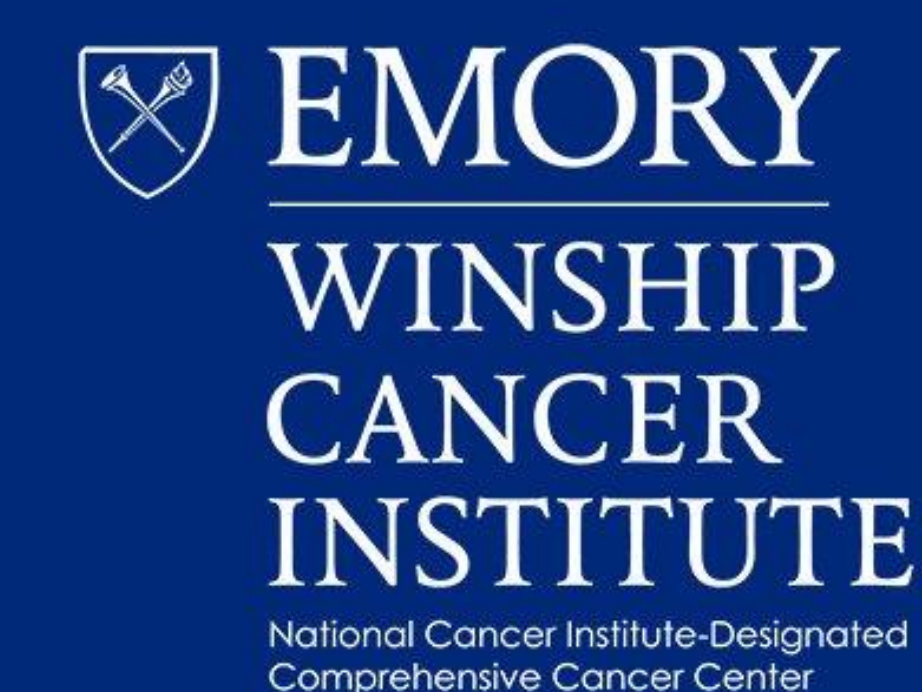


# Comparing Laterality-Specific and General Knowledge-Based Planning Models for Non-Small Cell Lung Cancer

Julia Seng<sup>2</sup>, BS; Kirk Luca<sup>1</sup>, MS; Justin Roper<sup>1</sup>, PhD; Aparna H. Kesarwala<sup>1</sup>, MD, PhD; Shadab Momin<sup>1</sup>, PhD

<sup>1</sup>Department of Radiation Oncology, Emory University, Atlanta, GA, USA

<sup>2</sup>Medical Dosimetry Program, Southern Illinois University, Carbondale, IL, USA



## INTRODUCTION

**Purpose:** To investigate the clinical impact of laterality-specific RapidPlan models for non-small cell lung cancer.

Knowledge-based planning (KBP) is a tool that helps minimize variations in the treatment plan quality and improve efficiency by simplifying the treatment planning process. It uses predictive dose-volume histogram (DVH) models from high-quality plans input into the system and can be trained to generate DVHs for different OARs and target structures.

A KBP model can be either specific or generalized. For instance, for a specific anatomical region, one may create either a general model that may be suitable for a variety of patient cases or a specific model that works best for a narrower range of patient cases.

## METHODS

### Model Creation

- VMAT lung cases previously treated at a single institution between 2019 and 2022 were used with a treatment regimen of 60 Gy in 30 fractions
- 50 right-sided cases and 50 left-sided cases were used to develop the left and right RapidPlan models. The general model was created by randomly adding 25 cases from each laterality-specific model

### Treatment Planning

- All plans were calculated on the Varian Edge using 6X and a 600 MU/min dose rate
- Acuros (Version 16.1.0) was used for the final dose calculation
- All three models shared the same optimization objectives and NTO settings
- Normalized such that the prescription dose covered 95% of the target volume

### Validation Cases

- Validation included 13 right-sided and 13 left-sided cases, none of which were used for model creation
- Optimized using each RapidPlan model without intervention
- Statistical analysis using a paired sample t-test ( $p < 0.01$ ) assessed dosimetric endpoints based on RTOG 0617 criteria

Right-Sided Validation Cases	General Model	Right Model	Left Model	p-value (General vs Right)	p-value (General vs Left)	p-value (Right vs Left)
Lungs V5	58.86±13.18	59.02±12.5	58.54±12.9	0.74	0.35	0.39
Lungs V20	22.01±8.59	22.39±8.60	22.64±8.56	0.86	0.012	0.13
Lungs Mean	13.75±3.29	13.86±3.23	13.86±3.22	0.08	0.25	0.99
Heart V40	4.00±4.78	3.95±4.59	4.04±4.76	0.69	0.53	0.32
Heart V45	3.13±4.00	3.08±3.85	3.13±3.97	0.56	0.85	0.34
Heart V60	1.32±2.12	1.36±2.13	1.39±2.13	0.04	0.03	0.30
Heart Mean	10.16±6.33	10.00±6.46	10.19±6.39	0.36	0.74	0.22
Esophagus V55	12.41±11.53	12.54±11.68	11.91±11.11	0.73	0.07	0.10
Esophagus Mean	18.38±8.53	18.75±8.63	17.82±8.58	0.04	0.04	0.009*
Esophagus Dmax	63.731±7.02	63.48±7.03	63.92±7.72	0.13	0.45	0.88
Spinal Cord Dmax	21.08±7.79	23.67±9.13	21.35±7.41	5.93E-04*	0.61	0.008*
Spinal Cord D0.03cc	21.33±5.77	24.08±7.02	21.83±5.30	1.29E-04*	0.36	0.008*
Brachial Plexus Dmax	26.12±28.67	26.40±28.62	26.26±28.81	0.44	0.26	0.69

**Table 1.** Dosimetric comparison results for the 13 right-sided validation cases. Statistical significance level was set to be p-value < 0.01.

Left-Sided Validation Cases	General Model	Right Model	Left Model	p-value (General vs Right)	p-value (General vs Left)	p-value (Right vs Left)
Lungs V5	62.99±17.78	63.82±17.86	62.68±17.74	0.099*	0.253	0.011
Lungs V20	24.53±9.04	25.52±9.50	26.38±10.15	0.002*	0.003*	0.016
Lungs Mean	13.90±4.24	17.08±11.27	14.04±4.34	0.270	0.351	0.291
Heart V40	4.07±4.96	4.37±5.35	4.09±5.03	0.140	0.752	0.157
Heart V45	3.25±4.11	3.40±4.23	3.29±4.18	0.127	0.269	0.233
Heart V60	1.54±2.40	1.53±2.37	1.55±2.44	0.754	0.401	0.570
Heart Mean	8.87±6.83	9.29±7.85	8.79±6.89	0.255	0.554	0.205
Esophagus V55	16.92±14.64	17.66±14.83	16.38±14.20	0.012	0.057	0.015
Esophagus Mean	22.82±9.04	23.62±8.81	22.26±8.73	4.13E-04*	0.026	3.68E-06*
Esophagus Dmax	64.18±6.84	63.93±7.22	64.37±6.29	0.241	0.415	0.187
Spinal Cord Dmax	25.43±4.60	27.85±5.75	25.06±4.96	3.33E-03*	0.521	0.187
Spinal Cord D0.03cc	24.22±4.44	26.55±5.58	24.05±4.66	0.005*	0.743	0.029
Brachial Plexus Dmax	30.83±30.29	30.74±30.23	30.78±30.19	0.273	0.651	0.641

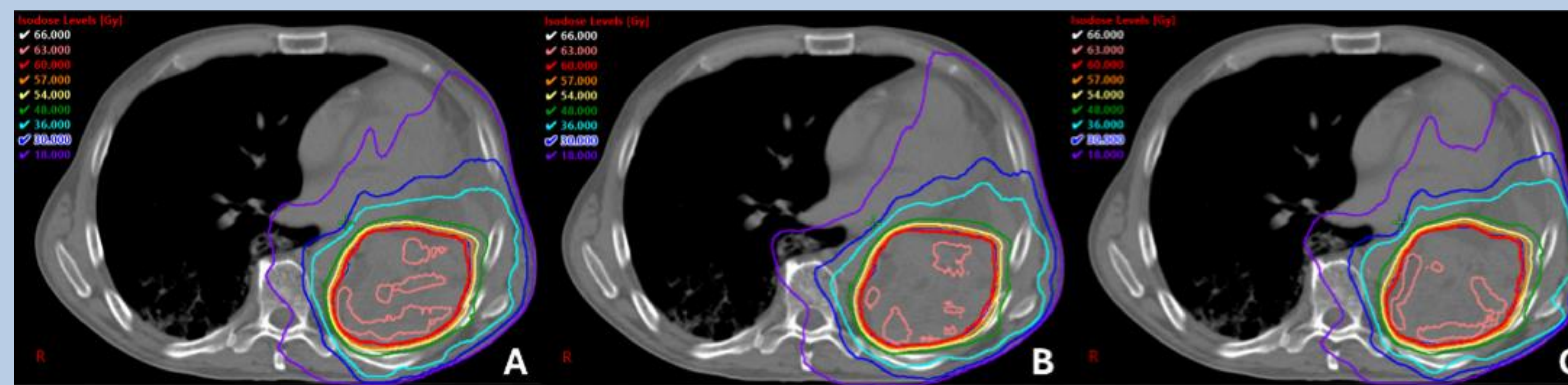
**Table 2.** Dosimetric comparison results for the 13 left-sided validation cases. Statistical significance level was set to be p-value < 0.01.

## RESULTS

**Right-sided validation cases:** There was a statistically significant decrease in spinal cord  $D_{max}$  (21.08 Gy vs. 23.67 Gy) and  $D_{0.03cc}$  of the spinal cord (21.33 Gy vs. 24.08 Gy) in the general model compared to the right-sided model. Additionally, there was a statistically significant decrease in the spinal cord  $D_{max}$  (21.35 Gy vs. 23.67 Gy),  $D_{0.03cc}$  of the spinal cord (21.83 Gy vs. 24.08 Gy), and esophagus mean (17.82 Gy vs. 18.75 Gy) in the left model compared to the right model.

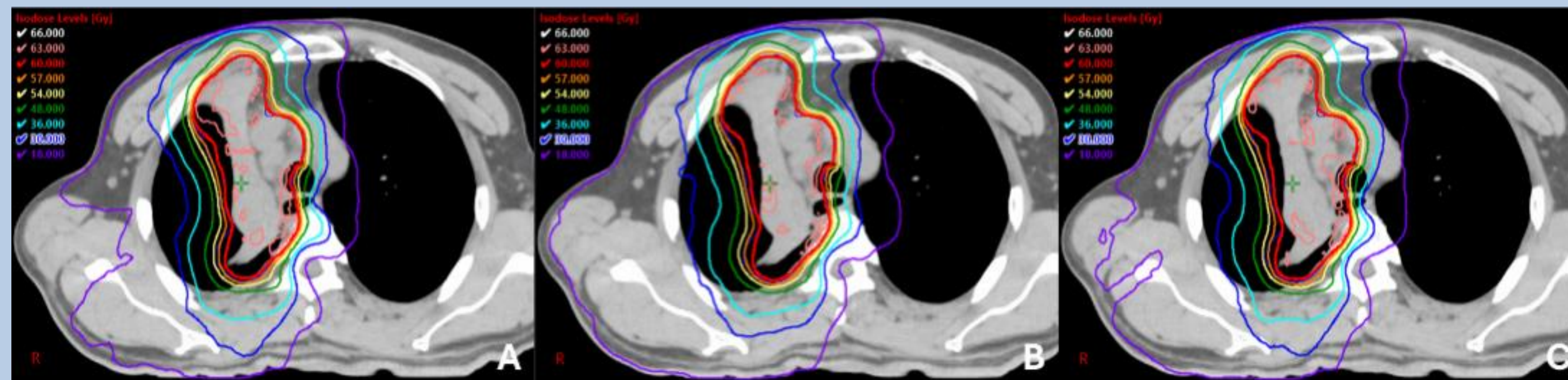
**Left-sided validation cases:** There was a decrease in V20 of the lungs (24.53 Gy vs. 26.38 Gy) in the general model versus the left-sided model. The general model outperformed the right model in the V20 of the lungs (24.53 Gy vs. 25.52 Gy), V5 of the lungs (62.99 Gy vs. 63.82 Gy), esophagus mean (22.82 Gy vs. 23.62 Gy), spinal cord Dmax (25.43 Gy vs. 27.85 Gy), and D0.03cc of the spinal cord (24.22 Gy vs. 26.55 Gy). The left model had a lower esophagus mean (22.26 Gy vs. 23.62 Gy) compared to the right model.

Although numerous statistically significant results were observed, none of these differences showed an overall difference in plan quality.



**Figure 1.** Example of the dose distribution for a left-sided case. The left image was planned using the general model (A), the middle was planned with the right model (B), and the right image was planned with the left model (C).

**Figure 2.** Example of the dose distribution for a right-sided case. The left image was planned using the general model (A), the middle was planned with the right model (B), and the right image was planned with the left model (C).



## CONCLUSIONS

Knowledge-based planning is a valuable tool for generating high quality treatment plans. The results of the study demonstrate that there is no additional benefit to having laterality-specific KBP models for NSCLC. Because only a general model is needed to produce high quality plans, this can significantly reduce the overall time it takes to develop a clinically usable KBP model.

## REFERENCES

