

Quantifying Temporal Trends and the Impact of Advances in Radiation Planning on Heart and Lung Dose for Lung Cancer Treatment Using a Machine Learning Model

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Purpose/Objective(s): Advances in radiotherapy (RT) planning have improved our ability to treat locally advanced non-small cell lung cancer (LA-NSCLC) while limiting damage to normal tissue. Machine learning models may further improve our RT planning by incorporating historic treatment insights to inform the optimal RT plan. We used such a model to quantitatively assess the impact of changes in planning techniques for LA-NSCLC on dose to critical normal tissues.

Materials/Methods: Treatment data from 232 patients with LA-NSCLC treated from 2010-2018 with conventionally fractionated 3D conformal RT (3DCRT) or intensity modulated RT (IMRT)/volumetric modulated arc therapy (VMAT) were collected. A model was used to predict patient-specific dosimetric data was built using a validating boosting framework that incorporates feature selection to avoid overfitting, utilizing a library of RT plans and patient features including anatomic information, clinical data, and RT prescription and delivery data. A hindcast model was created with patient data from 2016-2018, and used to predict heart and lung dose for patients treated from 2010-2012 and 2013-2015. To test algorithm integrity, a forecast model was created with data from 2010-2012, and used to predict heart and lung dose for patients from the subsequent era. Predicted and delivered dose metrics were compared using t-tests.

Results: From 2010-2012, 40 patients (85%) were treated with 3DCRT and 7 (15%) with IMRT/VMAT. From 2013-2015, 41 patients (53%) were treated with 3DCRT and 37 (47%) with IMRT/VMAT. From 2016-2018, 22 patients (21%) were treated with 3DCRT and 85 (79%) with IMRT/VMAT. The table shows predicted and delivered heart and lung dose metrics for the two models, stratified by treatment era.

Abstract 2301: Table 1.

Era	Mean heart dose (cGy)			Mean lung dose (Gy)			Lung V5 Gy (%)			Lung V20 Gy (%)		
	Predicted	Delivered	P	Predicted	Delivered	P	Predicted	Delivered	P	Predicted	Delivered	P
Hindcast Model Built on 2016-2018 Plans												
2010-2012	8.54	9.72	0.00	12.85	13.72	0.01	40.6	38.8	0.09	23.43	23.13	0.02
2013-2015	9.56	10.47	0.04	13.61	13.61	0.47	43.83	41	<0.001	23.76	23.78	0.98
2016-2018	9.5	9.5	0.8	14.11	14.11	0.7	48.77	48.77	0.7	23.68	23.68	0.8
Forecast Model Built on 2010-2012 Plans												
2010-2012	9.71	9.71	0.8	13.72	13.72	0.3	38.8	38.8	0.3	23.13	23.13	0.8
2013-2015	10.56	10.47	0.32	14	13.61	0.11	39.98	41	0.18	23.53	23.78	0.2
2016-2018	10.09	9.5	<0.001	14.64	14.11	0.01	41.44	48.77	<0.001	24.02	23.78	0.32

Conclusion: Predicted heart and lung metrics, except lung V5 Gy, were in general significantly lower than delivered metrics when using a model created with modern treatment planning techniques on earlier patient data, and vice versa. This is likely due to advances in RT planning techniques, particularly with increased adoption of and experience with IMRT/VMAT. Clinical decision support tools such as this may help leverage experience from prior plans to reduce dose to normal tissue such as the heart and lungs, thereby reducing RT toxicity.

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