Practical Radiation Oncology® (2022) 000, e1−e9

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Basic Original Report

Knowledge-Based Quality Assurance and Model Maintenance in Lung Cancer Radiation Therapy in a Statewide Quality Consortium of Academic and Community Practice Centers

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Received 7 July 2022; accepted 11 November 2022

Abstract

Purpose: Locally advanced lung cancer (LALC) treatment planning is often complex due to challenging tradeoffs related to large targets near organs at risk, making the judgment of plan quality difficult. The purpose of this work was to update and maintain a multi-institutional knowledge-based planning (KBP) model developed by a statewide consortium of academic and community practices for use as a plan quality assurance (QA) tool.

Methods and Materials: Sixty LALC volumetric-modulated arc therapy plans from 2021 were collected from 24 institutions. Plan quality was scored, with high-quality clinical (HQC) plans selected to update a KBP model originally developed in 2017. The model was validated via automated KBP planning, with 20 cases excluded from the model. Differences in dose−volume histogram metrics in the clinical plans, 2017 KBP model plans, and 2022 KBP model plans were compared. Twenty recent clinical cases not meeting consortium quality metrics were replanned with the 2022 model to investigate potential plan quality improvements.

Results: Forty-seven plans were included in the final KBP model. Compared with the clinical plans, the 2022 model validation plans improved 60%, 65%, and 65% of the lung V20Gy, mean heart dose, and spinal canal D0.03cc metrics, respectively. The 2022 model showed improvements from the 2017 model in hot spot management at the cost of greater lung doses. Of the 20 recent cases not

Sources of support: Michigan Radiation Oncology Quality Consortium (MROQC) is financially supported by Blue Cross Blue Shield of Michigan and the Blue Care Network of Michigan as part of the BCBSM Value Partnerships Program.

Disclosures: M.M., S.J., J.H., M.G., K.T., and R.M. receive salary support from Blue Cross Blue Shield of Michigan for MROQC coordinating center staff support. M.M. is both the MROQC Co-Director and Lead Lung Physicist. C.K.M. and M.M. have received honoraria for consulting work with Varian. C.K.M. has received an honorarium for presenting his research at a Radformation vendor symposium. M.M. has received clinical research funding from Varian and is a member of the American Association of Physicists in Medicine and Pediatric Proton Consortium Registry Advisory Boards.

Research data are not available at this time.

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https://doi.org/10.1016/j.prro.2022.11.009

meeting quality metrics, 40% of the KBP model-replanned cases resulted in acceptable plans, suggesting potential clinical plan improvements.

Conclusions: A multi-institutional KBP model was updated using plans from a statewide consortium. Multidisciplinary plan review resulted in HQC model training plans and model validation resulted in acceptable quality plans. The model proved to be effective at identifying potential plan quality improvements. Work is ongoing to develop web-based training plan review tools and vendor-agnostic platforms to provide the model as a QA tool statewide.

Introduction

Treatment plan quality is an important aspect that contributes to the effectiveness of radiation therapy as a treatment modality for lung cancer. Within a statewide consortium, we have tracked practice changes in radiation therapy treatment planning in conventionally fractionated lung cancer over the past 11 years.[1-3] During this time, treatment modalities have shifted from a majority of 3-dimensional conformal treatment plans to a majority of static beam intensity modulated radiation therapy plans and, most recently, to a majority of rotational volumetric modulated arc radiation therapy (VMAT) plans. As with many technologies, there is a learning curve to achieving the best plan quality as planning and delivery techniques change. In addition to changing techniques, the reality of radiation therapy treatment planning in a busy clinic means that there is not an unlimited amount of time allotted to plan each patient's treatment. The time spent pushing the boundaries of the treatment plan and iterating to reach the best-possible plan must be balanced with the clinical benefit and the workload of the clinic.

One of the goals of our statewide radiation therapy consortium is quality improvement and education regarding advanced treatment modalities in lung cancer radiation therapy. Seeing the quickly changing planning landscape, we wanted to develop resources to help with both plan quality control and improvement within the consortium. Although there are a number of potential mechanisms for this purpose, we focused on knowledge-based planning (KBP) as a tool that has previously shown promise in improving plan quality and efficiency within an institution and between dosimetrists.[4-7] This concept also has been implemented successfully for multi-institutional quality control in small multi-institutional consortiums and clinical trials,[8-12] but this concept has not often used the large multi-institutional data sets available in statewide radiation therapy consortiums to build and improve the model.

The purpose of this manuscript is to report on the work our consortium has done to update, validate, and apply a KBP model for locally advanced lung cancer (LALC). This manuscript also presents our preliminary work toward our primary aim of using the KBP model as a plan quality control and improvement tool within the consortium.

Methods

Michigan Radiation Oncology Quality Consortium

The Michigan Radiation Oncology Quality Consortium (MROQC) is a collaborative quality initiative that investigates the use of advanced technologies and quality across many aspects of radiation therapy for patients with breast, lung, and prostate cancer, as well as patients with bone metastases. The consortium began collecting anonymized patient clinical information, including baseline demographics, outcomes, and technical planning data, in 2011. Since then, the consortium has founded several site-specific working groups that focus on areas of quality improvement. Some examples of past assessments used to drive quality improvements by MROQC were related to breast hypofractionation, standardization of heart dose in LALC, and reduction of the use of extended fractionation in the treatment of bone metastases.[13-15]

KBP model update and validation

One of the quality projects undertaken by the MROQC Lung Working Group was treatment plan quality evaluation and potential improvement. After group discussion and some existing expertise within the consortium, KBP was chosen as a tool to employ within the project. An initial model was developed in 2017 based on a collection of 56 cases from 9 different institutions using RapidPlan (Varian Medical Systems, Palo Alto, CA), which has been previously presented.[16]

To leverage the planning expertise and diversity as well as new planning metric goals in the consortium, an updated RapidPlan model was developed from a collection of 60 cases from 24 different institutions participating in the project in 2021. All cases used a 2 Gy/fraction prescription and the total target prescription dose ranged from 58 Gy to 70 Gy. Institutions were encouraged to review contours before submission for compliance with the NRG Oncology (Philadelphia, PA) Lung Atlas and choose plans they deemed to be of high clinical quality. VMAT plans from 3 different treatment planning systems were represented in the submitted cases to evaluate for inclusion in the model. All plans were scored over a series of approximately 6 hours of multidisciplinary group

Table 1 Scoring schema for multidisciplinary case review of candidate KBP model plans

Contours and characteristics to evaluate	
PTV coverage, spinal canal, lungs-GTV, esophagus, heart, brachial plexus, overall conformality	
Score	Score description
1.	Excellent: any potential improvement would be very minor
2.	Good: clinically acceptable, but noticeable improvements are likely possible with additional planning effort and prioritization
3.	Unacceptable: the dose distribution to the structure in question should be improved

Abbreviations: GTV = gross tumor volume; KBP = knowledge-based planning; PTV = planning target volume.

sessions, which included multiple members of the consortium's Lung Working Group team. During each scoring session, the target and organs at risk (OARs) were evaluated for any major contour deviations from consortium standards. Dose distribution quality also was assessed qualitatively to identify whether plans had clear potential quality improvements without significant tradeoffs (eg, a reduction of contralateral lung volume receiving doses in excess of 20 Gy). Scoring was done for the planning target volume (PTV), spinal canal, esophagus, heart, normal lung, and brachial plexus (if applicable) as well as dose distribution quality. Scoring was done structure by structure on a scale of 1 to 3. Please refer to Table 1 for a complete description of what each score refers to. Scores were assigned in increments of 0.5 based on the consensus of the group.

Plans and structures with scores of 1, 1.5, and 2 were considered to be high-quality clinical (HQC) plans and were included in the updated KBP model. After scoring, plans or structures with scores of 2.5 or 3 were excluded from the model. Thirteen cases not included in the model were set aside for model validation. In addition to these validation cases, cases previously used to validate the 2017 model were used for validation.[16] The validation plans were replanned using both the updated 2022 KBP model and the previous 2017 KBP model. Relevant dose–volume histogram (DVH) metrics were compared between the models and the clinical plan. The model replanned cases were replanned with a clinical Varian Clinac iX beam model using 6MV VMAT deliveries optimized in Eclipse, version 15.6 (Varian Medical Systems). The deliveries were planned with 2 to 4 arcs, with the additional arcs being used to create partial field arcs to avoid the multileaf collimator travel limits in cases with large PTVs or to provide further degrees of freedom to optimization due to PTV overlap with OARs to better reflect dosimetrist clinical planning. Beam start-stop angles were decided based on tumor positions, with lateral tumors using half arcs and medial tumors using full arcs to replicate clinical planning methods. No additional optimization structures were created for optimization. The 2022 model cost function was refined iteratively by planning a number of the validation cases, reviewing the quality of the plans to ensure all high-priority consortium DVH metrics were met (Table 2), and making slight modifications to the cost function until metrics were met. The final cost function of the 2022 model and the cost function of the previously published 2017 model are shown in Table 3. Note that the 2022 model was created with ARIA, version 16.1.0 (Varian Medical Systems), whereas the 2017 model was created with ARIA, version 13.6.23 (Varian Medical Systems) and some cost function objectives were updated to use the new preference features of the line cost function objectives.

Table 2 MROQC Lung KBP metrics

Structure	Objective	Constraint
Spinal canal	D0.03cc	≤45 Gy
Lungs-GTV/ITV	V20Gy	≤35%
Lungs-GTV/ITV	Mean dose	≤20 Gy
Lungs-GTV/ITV	V5Gy*	≤65%*
Esophagus	D2cc	≤68Gy
Esophagus	Mean dose	≤34 Gy
Esophagus	D0.03cc	≤105%
Heart	V30Gy	≤50%
Heart	V50Gy	≤25%
Heart	Mean dose	≤20 Gy
Heart	D0.03cc	≤105%
Heart	D0.03cc	≤75 Gy
Brachial plexus	D0.03cc	≤66 Gy
PTV	D95%	≥100%

Abbreviations: GTV = gross tumor volume; ITV = internal target volume; KBP = knowledge-based planning; PTV = planning target volume.
* Priority 3 Goal, monitored but not used to identify cases for improvement.

Consortium plan quality evaluation

After model refinement and validation, the model was tested against plans that did not meet all consortium quality metrics to determine whether the model could be used to identify potential improvement in plans. In total, 20 VMAT lung cases were identified in the consortium database from 2021 that did not meet all consortium priority 1 and 2 metrics (Table 2). These cases had been filtered out by the consortium database for not meeting the consortium metrics when creating the model training and validation data set and therefore were independent from

Table 3 KBP model cost functions for the updated KBP model and the previously published 2017 model

Contour	Objective Type	Vol (%)	Dose	Priority
2022 model				
PTV	Upper	0	105.0%	240
PTV	Lower	100	101.5%	250
Brachial plexus	Upper	0	64.00 Gy	75
Brachial plexus	Upper (fixed vol., generated dose)	0	Generated	Generated
Esophagus	Upper	0	68.00 Gy	150
Esophagus	Upper	0	102.5%	275
Esophagus	Mean		32.00 Gy	75
Esophagus	Line (preferring OAR)	Generated	Generated	Generated
Heart	Upper	45	28.00 Gy	50
Heart	Upper	30	40.00 Gy	50
Heart	Upper	0	102.5%	300
Heart	Upper	0	73.00 Gy	150
Heart	Mean		18.00 Gy	150
Heart	Line (preferring OAR)	Generated	Generated	Generated
Lungs-ITV	Upper	33	18.00 Gy	150
Lungs-ITV	Upper	45	4.00 Gy	125
Lungs-ITV	Mean		18.00 Gy	190
Lungs-ITV	Line (preferring OAR)	Generated	Generated	Generated
Spinal canal	Upper	0	43.00 Gy	150
Spinal canal	Upper (fixed vol., generated dose)	0	Generated	Generated
2017 model				
PTV	Upper	0	105.0%	200
PTV	Lower	100	102.0%	250
Brachial plexus	Upper	0	64.00 Gy	75
Brachial plexus	Line (preferring target)	Generated	Generated	Generated
Esophagus	Upper	0	68.00 Gy	75
Esophagus	Mean		32.00 Gy	75
Esophagus	Line (preferring target)	Generated	Generated	Generated
Heart	Upper	45	28.00 Gy	50
Heart	Upper	30	40.00 Gy	50
Heart	Upper	0	103.0%	100
Heart	Mean		28.00 Gy	50
Heart	Line (preferring target)	Generated	Generated	Generated
Lungs-ITV	Upper	33	18.00 Gy	150
Lungs-ITV	Upper	45	4.00 Gy	150
Lungs-ITV	Mean		18.00 Gy	150
Lungs-ITV	Line (preferring target)	Generated	Generated	Generated
Spinal canal	Upper	0	47	150
Spinal canal	Line (preferring target)	Generated	Generated	Generated

Abbreviations: GTV = gross tumor volume; ITV = internal target volume; KBP = knowledge-based planning; OAR = organs at risk; PTV = planning target volume.
In addition to the contour specific components, both models had identical manual normal tissue objectives with a 125 priority, a 0.02 cm distance from target border, a 100% start dose, a 40% end dose, and a 0.05 falloff.

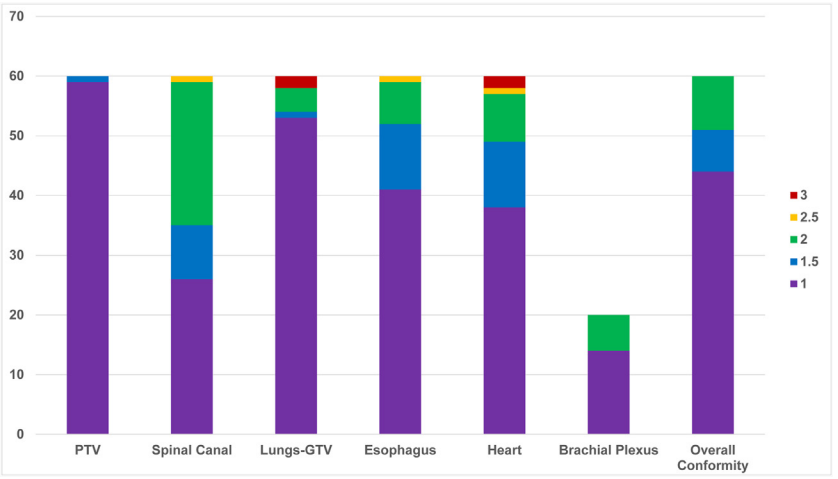

Figure 1 Plan quality scoring summary for HQC plans submitted for lung KBP model building. A score of 1 corresponded with excellent quality, 2 represented clinically acceptable quality, and 3 represented clinically unacceptable quality. *Abbreviations:* GTV = gross tumor volume; HQC = high-quality clinical; KBP = knowledge-based planning; PTV = planning target volume.

the model. The most common metrics not met were the goals of PTV coverage D95% ≥100% and heart mean dose ≤20 Gy. Each case was replanned using the 2022 KBP model in an automated fashion with no manual adjustment to the cost function provided by the KBP model. The clinical and KBP plan DVH metrics were compared, and differences were quantified to determine whether the KBP plans could meet plan quality metrics when the clinical plan did not.

Results

KBP model creation and validation

Figure 1 shows a summary of the plan quality scores for the 60 HQC lung plans submitted from the consortium institutions. The majority of structures and plan conformity were scored as 1 or 1.5. Spinal canal had the largest percentage of cases with scores worse than 1, whereas PTV had the fewest. Only a small number of structures scored a 2.5 or 3, denoting them as unacceptable or borderline unacceptable.

To build the KBP model, contours scoring worse than 2 were excluded. The final KBP model included 47 cases. In total, 13 cases were used for independent testing and validation of the model to ensure it was performing as intended. Seven cases were selected from the 2017 model validation data set to be included in the validation for the current updated model.

Table 4 shows the average differences in the DVH metrics as well as the results of paired, 2-sided Student *t* tests across the cohorts. Figure 2 shows the comparison of the DVHs resulting from the clinical plan, 2017 KBP model plan, and 2022 KBP model plan for one of the typical validation cases. In the 20 validation cases, it was found that in case specific comparisons, the metric improved in 2022 KBP model plans compared with the corresponding clinical plans for 50% to 80% of relevant DVH metrics. Despite this, overall, there were no statistically significant differences in any of the average values of the relevant target or OAR DVH metrics, with the dose metric difference average reductions ranging from −3.4 Gy to −0.2 Gy and the volume metric difference averages ranging from a 1.2% reduction to a 2.1% increase. In the comparison of the 2022 model with the 2017 model, it was found that in a case-by-case comparison, the 2022 model generally improved the hot spot control in the target and OARs at the cost of some target coverage, lung V20Gy and V5Gy, and esophagus mean dose. The differences in average OAR DVH metric values were not found to be statistically significant, but the improvements in target D0.1cc (%) and reduction of target D95% (%) were found to be statistically significant. It was found that the minimum D95% for the 2022 model plans was 99.8% and 17 of 20 plans exceeded 100%.

Quality evaluation in consortium cases

In the 20 consortium fallout cases, the KBP model found that 40% of the plans could be improved to meet all quality metrics. In all the improved cases, it was found that the KBP model could increase the target coverage without compromising any other quality metrics. In the 60% of cases that were not improved, it was often the case that the target coverage could be improved, but at the cost of a quality metric. Table 5 shows the evaluation of the consortium fallout cases on a metric-by-metric basis.

Table 4 Comparison of the plans created by the updated 2022 KBP model to the clinical plans and plans created using the previous 2017 model

		2022 KBP model vs clinical plan				2022 KBP model vs 2017 KBP model			
Contour	DVH metric	% Plans improved in 2022 KBP model	Average change (2022 KBP model − clinical plan)	Standard deviation	*P* value	% Plans improved in 2022 KBP model	Average change (2022 KBP model − 2017 KBP model)	Standard deviation	*P* value
PTV	D95% (%)	65	1.8	3.69	.0539	10	−0.3	0.5	.0350
PTV	D0.1cc (%)	65	−2.4	5.2	.0616	100	−1.8	1.0	.0002
Spinal canal	D0.03cc (Gy)	65	−1.47	6.84	.5844	60	−1.14	5.48	.6848
Lungs-GTV	V20Gy (%)	60	0.5	3.07	.8188	15	0.5	0.9	.8187
Lungs-GTV	V5Gy (%)	70	2.1	9.62	.6726	20	1.7	2.0	.7152
Lungs-GTV	Mean (Gy)	50	−0.56	2.02	.6385	20	0.22	0.36	.8514
Esophagus	D2cc (Gy)	60	−3.4	6.75	.4334	50	1.97	4.73	.7081
Esophagus	D0.03cc (%)	70	−2.9	13.16	.6464	75	−0.2	8.2	.9837
Esophagus	Mean (Gy)	65	−1.70	2.22	.527	20	1.42	1.34	.6127
Heart	V30Gy (%)	60	−1.2	3.67	.5976	45	0.3	2.1	.8892
Heart	V50Gy (%)	75	−1	1.88	.3493	40	0.0	0.6	.9759
Heart	D0.03cc (%)	80	−2.9	4.48	.7687	80	−1.9	3.6	.8466
Heart	Mean (Gy)	65	−0.9	1.89	.6498	55	0.06	1.24	.9791
Brachial plexus	D0.03cc (Gy)	66.7	−0.2	0.59	.9636	33.3	−0.13	0.52	.9815

Abbreviations: DVH = dose−volume histograms; GTV = gross tumor volume; KBP = knowledge-based planning; PTV = planning target volume.

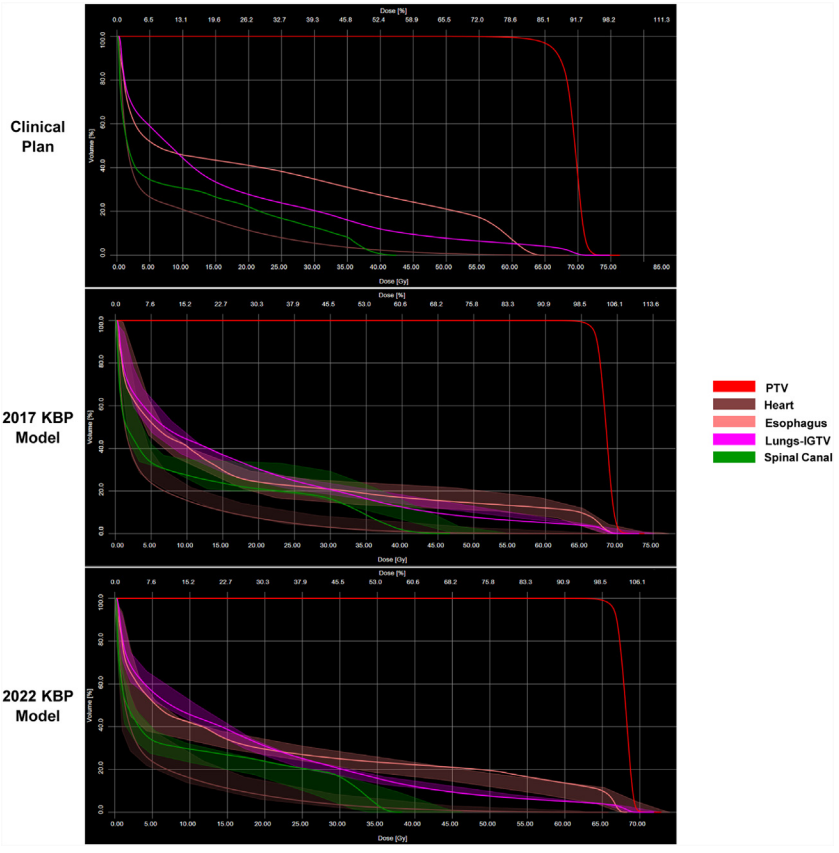

Figure 2 The clinical plan (top), 2017 KBP model plan (middle), and 2022 KBP model plan (bottom) DVHs from a single example case used for model validation. Note that the shaded areas around the KBP model DVHs represent the possible DVH range predicted by the KBP model. *Abbreviations:* DVH = dose–volume histograms; GTV = gross tumor volume; HQC = high-quality clinical; KBP = knowledge-based planning; PTV = planning target volume.

Table 5 Comparison of the consortium fallout cases to the plans created by the 2022 KBP model

Contour	DVH metric	% Clinical plans meeting quality metric	% 2022 KBP model plans meeting quality metric	% Failing clinical plans flagged for potential improvement of the metric by 2022 KBP model
PTV	D95% (%)	5	75	42
PTV	D0.1cc (%)	45	95	36
Spinal canal	D0.03cc (Gy)	90	90	50
Lungs-GTV	V20Gy (%)	90	60	50
Lungs-GTV	Mean (Gy)	100	80	N/A
Esophagus	D2cc (Gy)	100	95	N/A
Esophagus	D0.03cc (Gy)	70	100	50
Esophagus	Mean (Gy)	100	90	N/A
Heart	V30Gy (%)	100	100	N/A
Heart	V50Gy (%)	100	100	N/A
Heart	D0.03cc (%)	60	80	38
Heart	Mean (Gy)	90	100	0
Brachial plexus	D0.03cc (Gy)	100	100	N/A

Abbreviations: DVH = dose–volume histograms; GTV = gross tumor volume; KBP = knowledge-based planning; N/A = not available; PTV = planning target volume.
Note that in this study, a clinical case not meeting the DVH metrics was only considered flagged for potential improvement by the 2022 KBP model if the plan created by the model met all DVH quality metrics.

Discussion

In this study, a KBP lung model was updated, validated, and applied as a quality assurance (QA) tool for a statewide quality consortium. One major advantage of leveraging a statewide quality consortium database for the training of a KBP model is that this large, well-managed database provided the ability to quickly pull many plans meeting specific DVH quality metrics. This ensured that most of the plans and their contours were of acceptable clinical quality and only required a secondary check of contouring and plan quality, as shown by the plan review results of Fig. 1. Only 3 of the 60 cases reviewed had contours scored as unacceptable, 2 that did not have the gross tumor volume (GTV) subtracted from the Lungs-GTV contour, and one that had noticeable undercontouring of the heart adjacent to the target. An additional advantage of drawing from the consortium database was that a large number of different institutions, dosimetrists, and treatment planning systems were represented in the model. This larger breadth of cases improves the independence of plan quality checks by the KBP model because it prevents the model from becoming specific to any slight differences in an individual's planning style and better represents the consensus of the consortium.

The validation of the model on 20 treatment plans displayed the model's effectiveness at creating acceptable treatment plans. The comparison between the updated 2022 model and the original clinical plans showed that in case-by-case comparisons the 2022 model often improved on several relevant DVH metrics, but as displayed by the averages, standard deviations, and *P* values, these changes were not statistically significant because they often came at the cost of another metric becoming slightly worse. Part of the cause of this is that clinical tradeoffs from the clinical decision-making process of the radiation oncologist may not be perfectly captured by the KBP model. This could be potentially improved on with other automated and artificial intelligence-based planning techniques. In some cases, the very slight improvements by the KBP model were to meet more recently added goals of D0.03cc (%) ≤105% for the esophagus and heart. Overall, because the clinical plans were of good clinical quality that met consortium quality metrics, the lack of statistically significant difference between the average DVH values suggests that the KBP model is creating clinically acceptable plans.

The comparison of the updated 2022 model to the 2017 model displayed slight changes in dose DVH metrics but, overall, relatively similar results. The benefit of using the previous model in the validation of the new model was that it provided another layer of validation to the model update with a previously validated KBP model. In the case-by-case comparisons, the new model often improved upon Heart and Esophagus D0.03cc (%) and PTV D0.1cc (%) as a result of cost function goals added to the 2022 model to meet the updated 105% and 110% consortium goals, respectively. The differences in the OAR DVH metrics did not show statistical significance partially because of plans making dose tradeoffs to meet all planning goals and moving dose to OARs well below dose limits. The statistically significant changes in PTV coverage and hot spots were due to the 2022 model making the tradeoff of reducing target coverage to meet both the D95% goal and the PTV D0.1cc (%) ≤110% goal in the cost function. Although both models had cost function goals to reduce the PTV D0.1cc (%), the 2022 model had greater priority on the goal due to consortium's increased emphasis on the reduction of PTV hot spots since the establishment of immunotherapy as standard of care and the release of the results of Radiation Therapy Oncology Group 0617.[17]

The advantage of the updated KBP model as a QA tool was displayed by its application to cases that did not meet all consortium quality metrics. In the cases in which the model resulted in improved, clinically acceptable plans that met the consortium DVH quality metrics, it suggested that a patient's plan could have been of greater quality without unacceptable clinical tradeoffs. Most commonly in these improved plans, the model improved target coverage without exceeding critical OAR limits. If clinical tradeoffs had been made in the clinical plans due to target size or proximity to an OAR, in some of these cases the model was unable to create a plan that met all planning goals, as shown in Table 5. Often for these plans, the KBP model would slightly violate Lungs-GTV mean dose or V20Gy limits. In these cases, the KBP model showed that the clinical plan was of reasonable quality, given the geometry and the necessary clinical tradeoffs. If this model was provided to dosimetrists statewide, direct comparisons to the model during the planning process could be used as a QA benchmark to ensure that the current clinical plan is of the greatest quality possible. This is similar to the method implemented in the NRG-HN001 clinical trial, which used a KBP model to flag submitted plans where OAR sparing was improved by the KBP model by >5% to be sent back to institutions for replanning.[12] Initial distribution of the RapidPlan KBP model presented in this work as a QA tool is possible for other Varian users, but currently there are no commercial solutions for sharing this with non-Varian users. This drawback could be addressed and allow for statewide distribution of the model with the development of a vendor-agnostic cloud-based tool to allow for plans to be benchmarked against the model.

Although the process established in this work for developing and updating a KBP model for a statewide quality consortium resulted in an effective model for plan QA, the method and the use of KBP for QA have some drawbacks. It was found that the process of reviewing plans that could potentially be included in the model was a very time-consuming process that required the scheduling of 6 hours of meetings to review 60 cases. This could

potentially be alleviated with the use of a cloud-based online database that would allow for the asynchronous review of plans by a multi-institutional team. With a cloud-based system, model candidate plans from the consortium could be sent to the system and individuals could review plans as they are able. This would make the accumulation of HQC plans for model training a continuous and asynchronous process, allowing for more efficient and regular retraining of the model.

Another drawback in KBP itself is that when shifts occur in treatment planning goals and planning strategies, old models and plans become unfit for QA. As discussed by Faught et al,[18] this can be accomplished by either only including plans that reflect current priorities, which may require the accumulation of new training plans, or through the refinement of older plans to meet current goals. Also, to make the most robust and universal KBP model possible for a treatment site, it is necessary to train and tune the model based on a very wide range of target geometries, OAR geometries, treatment modalities, and prescriptions, which requires a very large training data set. Also, the inclusion of only plans that met all consortium quality metrics may have not captured situations in which a clinical tradeoff was necessary to maintain OAR goals while resulting in acceptable target coverage. In this work, the model included 47 HQC clinical plans, which may not have spanned the full range of LALC treatments and may partially be the cause of some of the fallout plans not being improved by the model. This could be improved in the future with continuous accumulation and review of training plans, which could be attainable with the large data set provided by a statewide quality consortium.

Conclusions

The process of updating, validating, and applying an LALC KBP model for a statewide quality initiative was described. The leveraging of similar multi-institutional databases shows potential for an effective way of developing a plan QA tool that can be applicable to a large number of clinics. With further improvements to the model training plan review and accumulation method, the improvement of these models can become a continuous process, making KBP potentially a valuable tool for benchmarking one's treatment plans quality to plan quality across an entire state. Work is currently ongoing in MROQC to find a vendor-agnostic solution to provide convenient access to the KBP model to as many clinics within the consortium as possible.

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