Refining complex re-irradiation planning through feasibility benchmarking and analysis for informed treatment planning

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Purpose/Objectives: The purpose of this study is to dually evaluate the effectiveness of PlanIQ in predicting the viability and outcome of dosimetric planning in cases of complex re-irradiation as well as generating an equivalent plan through Pinnacle integration. The study also postulates that a possible strength of PlanIQ lies in mitigating pre-optimization uncertainties tied directly to dose-overlap regions where re-irradiation is necessary.

Methods/Materials: A retrospective patient selection (n=10) included a diverse range of re-irradiation cases to be planned using Pinnacle auto-planning with PlanIQ integration. A consistent planning template was applied across all cases and direct plan comparisons of manual plans against feasibility-produced plans were performed by a physician with dosimetry recording relevant proximal OAR and planning timeline data.

Results: All re-irradiation cases were successfully predicted to be achievable per PlanIQ analyses with two cases [2/10] necessitating 95% target coverage conditions, previously exhibited in the manually planned counterparts and determined acceptable under institutional standards. At the same time, PlanIQ consistently produced plans of equal or greater quality to the previously manually planned re-irradiation across all [10/10] trials (p=0.05).

Proximal OAR exhibited similar to slightly improved maximum point doses from feasibility-based planning with the largest advantages gained found within the subset of cranial and spine overlap cases, where improvements upwards of 10.9% were observed. Mean doses to proximal tissues were found to be a 2.1% improvement across the entire study although not statistically significant. Documented planning times were markedly less than or equal to the time contributed to manual planning across all cases.

Conclusion: Initial findings indicate that PlanIQ effectively provides the user clear feasibility feedback capable of facilitating decision making on whether re-irradiation dose-objectives and prescription dose coverage are possible at the onset of treatment planning thus eliminating possible trial and error associated with some manual planning. Introducing model-based prediction tools into planning of complex re-irradiation cases yielded positive outcomes on the final treatment plans.

Discussion: While not a primary metric of our initial study, recorded planning times were found to be significantly less when incorporating feasibility analyses into the dosimetry workflow. It is believed that planning time was shortened as a result of eliminating optimization uncertainties tied to the refinement of dose objectives previously entered manually by the dosimetrist.

At this time our feasibility analysis program, PlanIQ, does not support dose summation between a DICOM file and the feasibility modeling system. If it were possible to export a previous treatment dose to the benchmarking application, upon which the feasibility analysis could provide feedback on our new objectives and the prior dose, we could eliminate manual dose segmentation and reduce possible human error even further.

Furthermore, patient accrual for this retrospective study has continued to increase as our institution looks to incorporate feasibility analyses into the planning workflow. At the time of this poster printing a total of eleven (11) patients have been planned and recorded for statistical analysis.

Manually-Generated Feasibility-Based

Figure 1: Patient population is represented by a wide range of diverse cases.

Figure 2: Dosimetry workflow demonstrated from dose fusion to setting objective values and feasibility analyses that would be used for IMRT/SBRT optimization for re-irradiation.

Figure 3: A side-by-side comparison of “manually” optimized treatment plan DVH(s) and those generated through “feasibility-based” techniques.

Figure 4: Observed treatment planning times for “manual” and PlanIQ are compared to illustrate the benefit in reducing pre-optimization uncertainties tied to dose overlap regions.

Figure 5: The primary metric for statistical comparison showed some improvements when using feasibility analyses to reduce mean doses across all proximal OAR for each patient.