Data-Driven Dose Volume Histogram Prediction

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INTRODUCTION

Model- and Data- driven DVH prediction are becoming routine in radiation oncology. However, clinical radiation oncology has inherent variables which models are naïve to (e.g. OAR preference); furthermore, a variation as simple as a beam angle adjustment can allow for zero dose to OARs which do not overlap the PTV. Utilizing and assessing prior patient data is paramount to developing robust and knowledge-based planning capabilities.

AIM

To introduce methods to query and interpret prior patient data; and demonstrate the utility of prior data in predicting prospective clinical treatment dosimetry. To assess the potential of our query to predict various organs DVH based on prior patient data.

METHOD

Database of 122 locally advanced lung patients was constructed utilizing Oncospace schema and was utilized to assess the efficacy of our 2-point Overlap Volume Histogram (OVH) query

The 2-point OVH query is justified due to:
(1) Advanced lung cancers use uniform prescriptions, therefore OVH (d<=0) provides no additional information to OVH (d=0)
(2) OVH (d>2 cm) has large variations due to planning

Evaulate two metrics:
(1) OVH variation as a function of distance from PTV for various organs and number of patients queried
(2) Clinical plan's DVH ($DVH_{clinical}$) compared to the predicted DVH (DVH_{pred})

Prior data is filtered using IQR (interquartile range) and whisker (non-outlier range) using the following algorithm:

Combining Prior DVH Data to create predicted DVH (DVH_{pred}):
1. Create 10 dose bins on the relative dose interval 0-120%.
2. For each bin, compute the 25th and 75th percentile data and the inter quartile range of all DVH data
   1. IQR = 75th – 25th percentile
3. Define upper and lower "whiskers" 1.5*IQR > and < the 75th and 25th percentiles, respectively
4. Define outliers as all data points > or < than the "whiskers", remove outliers
5. Display 10 boxplots directly over the relative volume vs. relative dose DVH plot

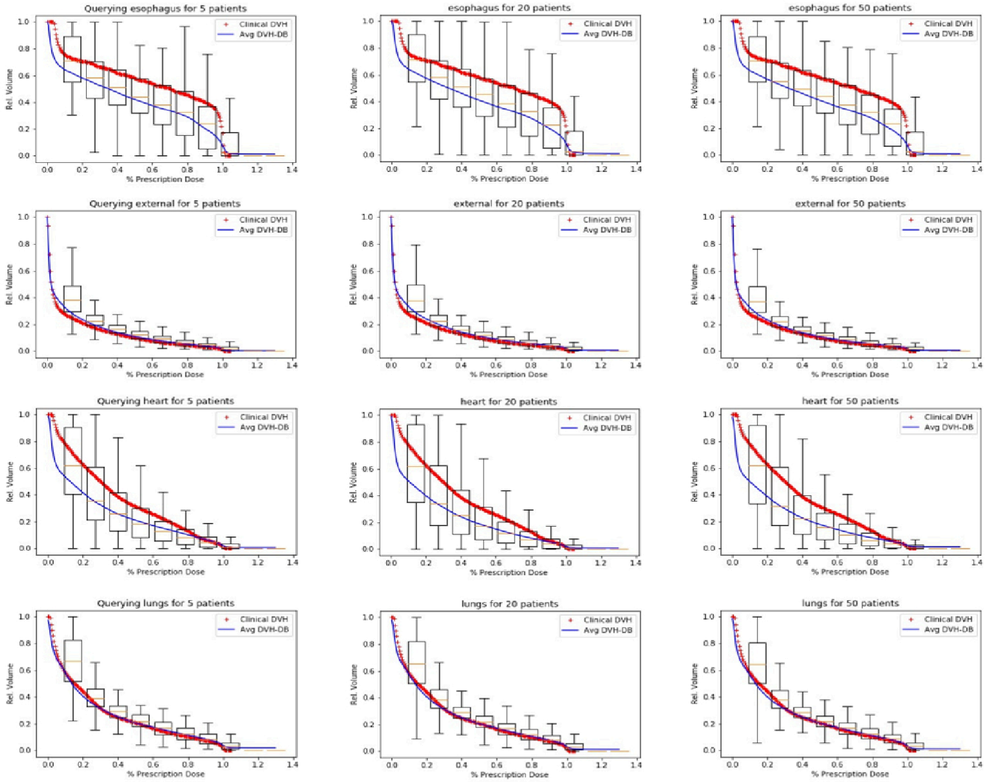
RESULTS: CLINICAL DVH DATA CAN BE PREDICTED WITH AS FEW AS 5 SIMILAR PATIENTS

Average error (err) between the $DVH_{clinical}$ and DVH_{pred} for the various organs DVH:

Esophagus: <10% for 11/23 patients
Heart: <10% for 13/23 patients
External: <4.6% for 21/23 patients
Lungs: <3% for 14/22 patients

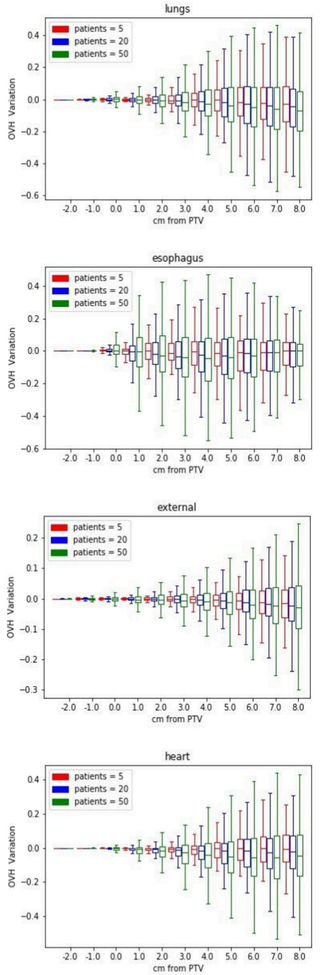
Inter-Quartile Range Variation at 2.0 cm between 5, 20, and 50 patients:

Esophagus: 5%, 8%, 25%
Heart: 1%, 2%, 5%
External: 1%, 2%, 5%
Lungs: 2%, 4%, 6%



Rows show clinical and predicted DVH for same patient across N similar patients (N = 5,20, and 50). IQR and NOR are shown as a boxplot, the blue line is the average DB-queried DVH, and the red DVH is the clinical plan.

OVH Variation for various organs as a function of number of similar organs queried



CONCLUSIONS

There is small variation in the OVH of OARs when within 2.0 cm of the PTV, with variation increasing with number of similar patients included. We showed that prediction is reasonable in organs that contain the tumor and have a known overlap (lungs and external), but for non-overlapped structures (heart and esophagus) planning preference and plan design are the dominant factors in determining dose. The results indicate that planning for organs that do not overlap with PTV may be best achieved through planning preference and potentially simple variations such as beam delivery and beam angle.

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