

## Improved organ at risk dose prediction model for head and neck VMAT

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### Abstract

#### Introduction

Head and Neck (H&N) radiotherapy plans show a large degree of variability in shape and position of the target volume in relation to nearby organs at risk (OAR). This means it is difficult to set generic plan optimisation objectives for OAR dose which are suitable for all plans. Instead it is common to iteratively refine OAR dose objectives during planning to achieve an optimal solution for each case. This process involves multiple, time-consuming plan optimisation steps. In this work we develop a predictive model of achievable OAR dose based on a library of existing H&N VMAT plans. This allows individualised OAR dose objectives to be set for each patient, thus saving time by reducing the number of optimisations required during planning.

#### Methods

A new 2-dimensional model to predict OAR dose was developed, providing improved prediction accuracy compared to prior work using 1-D models [1, 2]. Data from 160 recent H&N VMAT plans was used to build the model. For each patient a series of expansions of the PTV were created (2-20mm in 2mm steps), and the overlap of each expansion with each of four OARs was calculated (right and left parotid, larynx and oral cavity). The overlap volume was plotted as a function of PTV expansion, and a straight line fitted to the data. This yields measures of the OAR proximity to PTV (x-axis intercept of the line, X) and of OAR orientation relative to the PTV (gradient of the line, M). Higher gradient indicates that overlap increases more quickly with PTV expansion. The OAR dose achieved in the clinical plan was plotted in 3D against X and M. Finally a 2nd-order polynomial surface was fitted to the OAR dose vs. X and M data, to form the prediction model. Separate models were generated for parotids and oral cavity/larynx. Success of the model was tested by generating new plans for seven patients using the OAR dose objectives predicted by the model. Plan quality after a single optimisation was compared to the accepted clinical plan, in terms of PTV coverage and dose to OARs.

#### Results

The model was able to predict clinical plan OAR doses with a mean error of less than 40cGy and standard deviation of 309cGy (parotids)/432cGy (oral cavity/larynx).

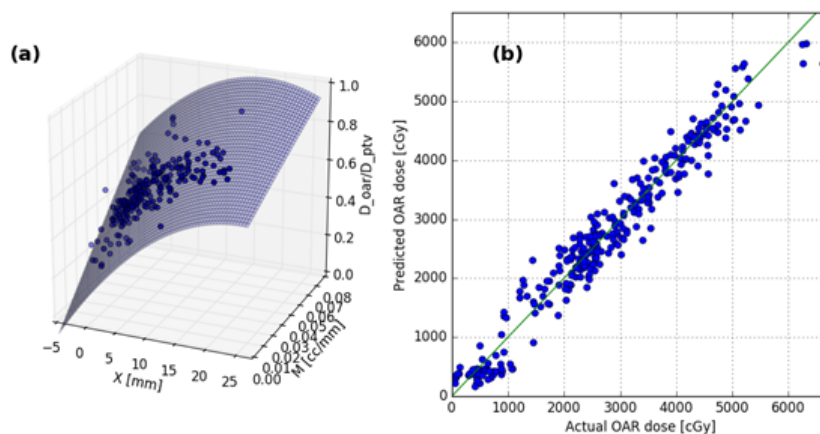


Figure 1: (a) Model fit to parotid dose vs proximity and orientation metrics (b) Predicted vs actual parotid dose for 160 plans.

New plans generated with a single optimisation had PTV coverage and OAR doses generally similar to (within 4%) or better than the original clinical plan, except for one case where the OAR was far from the PTV and received a very low dose.

#### Conclusion

An improved predictive model of OAR doses for H&N VMAT planning has been developed. It is anticipated that the model can be applied to save time during planning by reducing the number of optimisation steps required.

#### References

- [1] Moore, et al. (2011) 10.1016/j.ijrobp.2010.11.030
- [2] McWilliam & Pilkington (2014), 10.1016/S0167-8140(15)31740-0