A Parametric Approach Towards New Proton Facility Shielding Considerations in the Era of Proton FLASH Therapy

The James
THE OHIO STATE UNIVERSITY
COMPREHENSIVE CANCER CENTER

Authors: N Gupta[1], D DiCostanzo[1], A Ayan[1], J Woollard[1], J Meissner[2], K Hintenlang[1]

1 The Ohio State University, Columbus, OH

2 Meissner Consulting GmbH, Munchen, DE

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INTRODUCTION

With the advent of the modern era of proton therapy with consideration for hypofractionated / FLASH treatments, the traditional paradigms/assumptions of barrier thicknesses calculation would lead to wall thicknesses that are considerably larger than existing designs.

METHOD

Our institution has evaluated facility shielding for our recently acquired proton equipment, with considerations towards future implementation for clinical FLASH treatments. We have developed a parametric approach to help develop shielding assumptions that are realistic and not too conservative. This method uses the following input data:

a) target volumes by disease sites extracted from our treatment planning database for a five year period;

b) prescribed doses for different disease sites;

c) expected disease site breakdown;

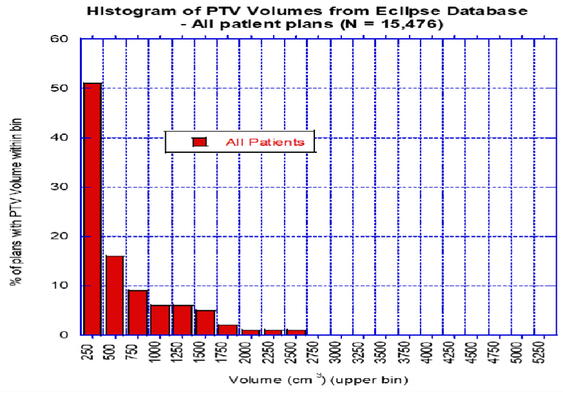
d) best estimates of conventional and FLASH/hypo-fractionated case mix along with the daily dose for each modality; and

e) treatment times for different complexity of treatments.

RESULTS

Figures 1 - 3 show some of the data used to drive our calculations. The model we developed is an empirical calculator that uses assumptions from traditional proton shielding calculations (patients/hr, dose per fx, avg target vol) and resulting shielding wall thicknesses and allows one to input different clinical use parameters and appropriately weights them to recompute the wall thicknesses interactively. This allows for varying patient mix, target volume mix for different disease sites and treatment times for different complexity of treatments to factor into more realistic workloads.

FIG: 1



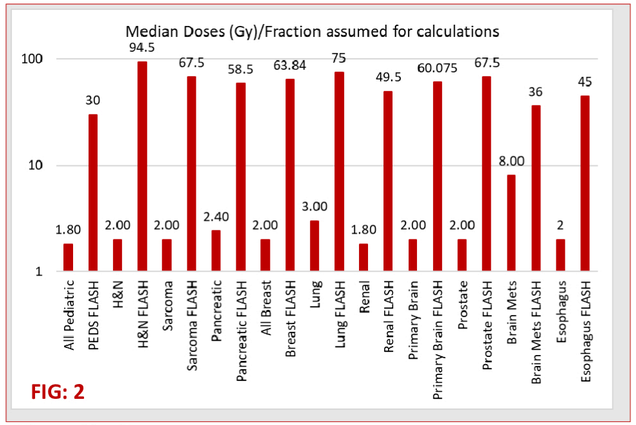


FIG: 2

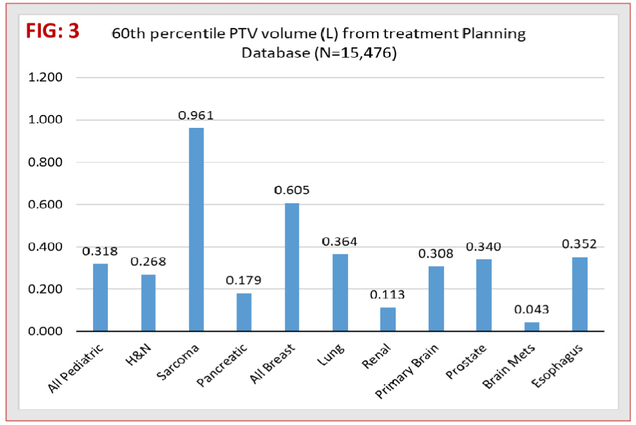
Figure Captions:

Figure 1*: Histogram of PTV volumes for all disease sites from our treatment planning database*

Figure 2*: Median prescription doses per fraction to the PTV assumed in our model for different disease sites for standard and FLASH delivery*

Figure 3*: 60th percentile PTV volume in L by disease site that were used in our calculation model*

FIG: 3



DISCUSSIONS

Our model allows us to appropriately weight all the parameters, allowing for different levels of conservativeness. The output of our model can be weighted averages for target volumes, dose/fraction and the patients per hour as assumptions for empirical shielding calculations. Additionally, these parameters can be inputs for Monte Carlo calculations for different scenarios to parameterize the source terms directly into the weighting to allow for the most realistic calculation of barrier thicknesses – an effort currently underway.

CONCLUSIONS

We feel that our approach towards calculating barrier thicknesses calculation assumptions will allow us to adequately account for FLASH and other proton treatments realistically and serve as a systematic approach for future facility design, and factor in appropriate design margins and not just scale current shielding arbitrary to account for FLASH.

CONTACT INFORMATION

Nilendu Gupta – Nilendu.Gupta@osumc.edu