AbstractID: 10371 Title: Dose to water versus dose to medium in proton beam therapy

Purpose: Dose in radiation therapy is traditionally reported as dose-to-water, D_w. Monte Carlo (MC) dose calculations report dose-to-medium, D_m. A methodology is needed to convert D_m into D_w for comparing MC and planning system results. This work addressed the following questions for proton therapy:

1. What formalism allows the conversion from D_m to D_w?
2. Can we convert MC calculated D_m into D_w retroactively or do we have to convert during particle tracking?
3. What is the difference between D_m and D_w when analyzing patient data in terms of dose distributions, dose volume histograms and absolute doses?
4. Is there a difference in the predicted beam range between D_m and D_w?

Method: We did develop a formalism to convert D_m into D_w for proton beam dose calculations. Three different methods are introduced, an approximate method based on relative stopping power which allows retroactive conversion, a method considering energy dependent relative stopping powers, and a method incorporating nuclear interaction events as well. A total of 33 patient fields were analyzed. MC calculated dose distributions, dose volume histograms and absolute doses to assess the clinical significance of differences between D_m and D_w were compared.

Results:

We found that the difference between the three conversion methods was within 1% in most cases when analyzing mean doses to contoured structures. Further, we found that the difference between D_m and D_w can be up to 10% for high CT numbers. The difference is clinically insignificant for soft tissues. For proton beams stopping in bony anatomy, the predicted beam range can differ by 2-3 mm when comparing D_m and D_w.

Conclusion: For comparison between MC and analytical dose distributions in proton therapy, a dose conversion is required. However, retroactive conversion seems to be sufficiently accurate in most cases, except for the end of range.