

Purpose:

To investigate the impact of variations in the image value to density table on TomoTherapy® dose calculations.

Method and Materials: An image value to density table (IVDT) was generated using the CT images of a solid water phantom with various tissue equivalent inserts. Additional density points were obtained by imaging a cylinder containing water, as well as the surrounding air. One IVDT was generated which included mappings for air and water, but only included tissue-inserts with HU values outside of the -100 to +100HU range, to avoid undue influence from the tissue-inserts in the critical density around water. For comparison, two other IVDT's were generated that a) did not include a mapping for air, or b) included the tissue-inserts in the -100 to +100HU range. All image values were mapped to the physical density of each material. An IMRT plan was generated with a cylindrical target volume near the center of the solid water phantom, and DQA doses were calculated using each of the IVDT's.

Results:

Without including an explicit mapping for air, the default IVDT only included a point mapping -1024HU to 0 g/cc density. Since the mean air CT value was near -1000HU, the IVDT without an air mapping resulted in air being mapped to a density of approximately 0.024 g/cm³, versus a correct value of 0.001 g/cm³. The artificially high density and corresponding increased attenuation resulted in a reduced dose to the target volume of only 0.7%. However, the increased scatter through air elevated the surface dose by 3 – 4%. Including all tissue-inserts in the IVDT increased the resulting mapped density of the solid-water phantom by 4%, and reduced the calculated dose delivered to the target by 2.2%.

Conclusion: Small variations to the IVDT generation process can have a measurable impact on the resulting calculated dose.