Evaluation of Lung Treatment Deliveries Using the Radiological Physics Center’s (RPC) Thorax Phantom: Monte Carlo vs. All Other Modern Heterogeneity Correction Algorithms.

D. Followill, P. Alvarez, M. Gillin and G. Ibbott
The University of Texas M. D. Anderson Cancer Center, Houston, TX U.S.A

Introduction
The Radiological Physics Center (RPC) was established as a resource in radiation dosimetry and physics for cooperative clinical trial groups and radiotherapy facilities that deliver radiation treatments to patients entered onto cooperative group protocols. The RPC’s primary responsibility is to assure NCI and the cooperative groups that the participating institutions deliver radiation treatments that are clinically comparable to those delivered by other institutions in the cooperative groups. One of the remote audit techniques used by the RPC to assure NCI is to credential institutions using its anthropomorphic phantoms, i.e. an end to end test from imaging to planning to final dose delivery as if the phantom were an actual patient. One of the phantoms that the RPC employs is its thorax phantom with a 3 cm target located in the center of the left lung. With the recent the implementation of several lung protocols requiring heterogeneity corrected target doses, the RPC, through its credentialing activities has evaluated numerous heterogeneity correction algorithms as used in various treatment planning systems.

Materials & Methods
The thorax phantom (figure 1) is a water–filled plastic shell that simulates a patient not only in dimensions but also in densities with a standard collapsed cone) algorithms, Varian Eclipse AAA algorithm, TomoTherapy planning station SC algorithm, Accuray Pinnacle superposition convolution (SC) (adaptive convolve and heterogeneity correction algorithms analyzed include Elekta Analytics Anisotropic Algorithms (AAA) are good media.

Results
Over the past 7 years, the thorax phantom has been mailed to 430 institutions (figure 3) wanting to be credentialed to participate in lung clinical trials. Criteria for passing the thorax phantom irradiation test were developed from a pilot study of 12 initial thorax phantom irradiations choosing the 90% confidence interval as the acceptance criteria. The investigation was supported by PHS grants CA21661, CA10953 and CA81647 awarded by the NCI, DHHS.

Conclusions
1. The Monte Carlo heterogeneity correction algorithm agrees better with the measurements in the RPC’s thorax phantom than SC or AAA algorithms.
2. The Superposition Convolution (SC) algorithms and the Analytical Anisotropic Algorithms (AAA) are good heterogeneity correction algorithms that are consistent under the same conditions.
3. A separate criterion of 1.00 ± 0.05 for the RPC/Inst. PTV dose ratio will be used for the MC calculated treatment plans in addition to the 0.97 ± 0.05 for the SC and AAA calculated treatment plans.
4. Further analysis of the differences between the SC/AAA and the MC algorithms is needed to better understand why the SC and AAA algorithms overlap the dose to the PTV in lung heterogeneous media.

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