

Purpose: Electron radiotherapy (RT) offers a number of advantages over photons. The high surface dose, combined with a rapid dose fall-off beyond the target volume presents a net increase in tumor control probability and decreases the normal tissue complication for superficial tumors. The current techniques involving electron RT are more seldom used than photon therapy due to the complexity of the electron transport involved and greater error in planning accuracy. Electron treatments are normally delivered clinically without previously calculated dose distributions. Our current research aims to use Monte Carlo (MC) methods to model clinical electron beams in order to accurately calculate electron beam dose distributions in patients. In addition to this, electron output factors can be quickly calculated, reducing the need for a clinical measurement.

Methods: The present work is incorporated into a research MC calculation system: McGill Monte Carlo Treatment Planning (MMCTP) system. MMCTP streamlines the calculation of output factors for various electron beam energies and applicator sizes. Measurements of PDDs, profiles and output factors in addition to 2D EBT-2 GAFCHROMIC measurements in heterogeneous phantoms were obtained to commission the electron beam model.

Results: Forty-nine output factors were measured and calculated. The mean percentage difference between measured and calculated was 1.35% with a maximum of 3.27%. The mean error and calculation time of the calculations were found to be 1.64% and 2 hours respectively. A dose difference of 3% and distance-to-agreement of 3 mm were used to compare two dimensional dose maps using the gamma method, yielding a good outcome.

Conclusions: The use of MC for electron TP will provide more accurate treatments and yield greater knowledge of the electron dose distribution within the patient. The calculation of output factors could invoke a clinical time saving of up to 1 hour per patient.