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Dose distribution of a radioactive point source near phantom surface

Abstract

In medicine, harmful effects of ionizing radiation on biological material are used for treatment of malign tumors. To optimize radiation exposure of tumor tissue and maximal protection of healthy tissue, an individual treatment plannig is nessesary. Additional to charactaristics of irrdiation source, scattering, and adsorption the applied dose is dependent on the size of patient's body.

The formalisms from literature to calculate dose distributions inside patient's body deliver a too high dose near body surface, when treated with a ^{192}Ir-source by means of brachytherapy. From 2500 single measurements at 32 locations each in a water phantom as well as in a perspex phantom data are acquired, to determine three constants for a new supplement of existing formalisms, which predicts the dose decrease near body surface. The ratios of material constants from both sides of the bounds water/air and perspex/air for the new geometry function are determined to $(\sigma_1/\sigma_2)_{water} =$ 1/1,23 and $(\sigma_1/\sigma_2)_{perspex} =$ 1/1,26 respectively. From dose values collected in both phantoms the constant in the extension of radial dose function is determined to $\alpha = 0{,}001\ cm^{-1}$.

The Monte Carlo simulation program EGS-ray verifies the dose distribution, calculated with the new model, at places from where no experimental data exist. A comparison between the dose distributions calculated with both, the new formalism and Monte Carlo simulation shows a excellent congruence.

Today the common calculation models show up to 25% too high dose values near phantom surface. These deviations are confirmed by measurements, Monte Carlo simulations, and the new formalism. With the here presented model dose distributions for brachytherapy of patients can be calculated correctly even at places which border on air filled volumes. Due to short computer time of this formalism needed on a practical computer in radiotherapy, correct dose calculations can be done in clinical routine.