AbstractID: 2969 Title: Derivation of the Relative Biological Effectiveness of High Dose Rate ²⁵²Cf Brachytherapy

Purpose:
While there is significant clinical experience using both low- and high-dose rate (HDR) ^{252}Cf brachytherapy, there is minimal data regarding values for the neutron relative biological effectiveness (RBE) with both modalities. The aim of this research was to derive a radiobiological model for ^{252}Cf neutron RBE and to compare these results with neutron RBE values used clinically in Russia.

Method and Materials:
The linear-quadratic (L-Q) model was used as the basis to characterize cell survival following irradiation, with identical cell killing rates ($S_N = S\gamma$) between ^{252}Cf neutrons and photons used for derivation of RBE. Using this equality, a relationship among neutron dose and L-Q radiobiological parameter (i.e., α_N, β_N, α_γ, β_γ) was obtained without need to specify the photon dose. These results were used to derive the ^{252}Cf neutron RBE which was then compared with Russian neutron RBE values. The ^{252}Cf neutron RBE was determined after incorporating the L-Q radiobiological parameters obtained from cell survival studies with fast neutrons and teletherapy photons.

Results:
For single-fraction HDR neutron doses of 0.5, 1.0, and 1.5 Gy, the total (neutron plus photon) doses were 3.5, 6.0, and 8.1 Gy, with ^{252}Cf neutron RBE values of 6.4, 5.5, and 4.9, respectively. Russian clinicians obtained HDR ^{252}Cf neutron RBE values ranging from 7 to 3 for similar doses and fractionation schemes, and observed that ^{252}Cf neutron RBE increases with the number of fractions and is dose rate dependent. A value of 5 was obtained for HDR ^{252}Cf neutron RBE.

Conclusion:
The methodology presented herein presents a reasonable technique to utilize well-characterized radiobiology parameters from radiation sources having similar radiobiological properties towards obtaining calculated values for RBE. Using these relationships, results were in general concordance with ^{252}Cf RBE values obtained from Russian clinical experience.