AbstractID: 7831 Title: Plan evaluation for interstitial seed implants containing a mixture of radio-nuclides with different half-lives

When radionuclides of different half-lives are used in a same permanent seed implant, the physical dose alone is no longer adequate to evaluate the radiation effects of the implant as the tumor cell proliferation and sub-lethal damage repair are strongly dependent on the temporal dose delivery pattern. In such an implant, the temporal dose delivery pattern is determined by the relative dose contribution from each radionuclide type and is variable throughout the implant volume. To properly evaluate such an implant, a linear-quadratic model for continuous-low-dose-rate irradiation was developed and a formula of biologically effective dose (BED) for implants containing any number of radionuclide types was obtained. Using the generalized BED formula, the effects of cell proliferation and sub-lethal damage repair were examined systematically for an actual implant containing a mixture of $^{125}$I and $^{103}$Pd seeds. It was shown that the traditional dose prescription to an isodose surface becomes non-unique in such an implant. When the prescription dose was based on existing clinical experience of using $^{125}$I seeds alone, mixing $^{103}$Pd seeds with $^{125}$I would further decrease the cell survival. On the other hand, if the prescription dose was based on existing clinical experience of using $^{103}$Pd seeds alone, mixing $^{125}$I seeds with $^{103}$Pd in a same implant would create radiobiologically “cold” spots (an increase in cell survival from the clinical expectation) at locations where a major portion of prescription dose is contributed by the $^{125}$I seeds. For fast-growing tumors, these "cold" spots can become significant factors in plan evaluation.