Contribution ID: **48** Type: **Poster**

Fluorescent Imaging of the Radiation Dose Surrounding an Iridium-192 Seed Used in Brachytherapy

Monday, 17 September 2012 17:30 (1h 30m)

The energy transferred to the medium surrounding a small seed of a radioactive isotope decreases steeply with distance from the seed and depends on the nature of the particulate and/or electromagnetic radiation emanating from it. This highly-localized dose distribution is used to effect in brachytherapy for the radiotherapeutic treatment of malignant tumours. Accurate monitoring of such a steeply-varying dose distribution requires ideally a dosimetric technique capable of three-dimensional, sub-millimetre spatial resolution. We have developed such a technique that is based on a gel medium that becomes fluorescent on exposure to ionizing radiation with the intensity of the fluorescence proportional to the local radiation dose. We illustrate the method with photographic images of the fluorescence surrounding a high dose rate (HDR) seed of iridium-192. The images, with a spatial resolution of better than 0.1 mm, were made in situ and could be recorded in real time during the course of irradiation using time-lapse or video recording modes. The gel is close to tissue-equivalent and its radio-fluorogenic property is based on the radiolytic formation of reactive free-radicals. The measurements are therefore directly relevant to the radio-biological processes responsible for the destruction of malignant tissue. This method of real-time, 3D dosimetry should expedite the research, development and application of radio-nuclides for radiotherapy and provide a visual image that could be of use in the education and training of clinical personnel.

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Session Classification: Poster Session

Track Classification: Radiopharmaceutical chemistry, radiodiagnostics, radiotherapy, theragnostics