THE CURRENT STATUS OF THE Os$^{191}$+Ir$^{191m}$ GENERATOR

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INTRODUCTION

The use of ultrashort-lived isotopes for radionuclide angiography has been the subject of increasing interest in recent years. While Tc$^{99m}$ has been used successfully for angiocardiology it suffers from several disadvantages because of its long half-life (1,2). While ultrashort-lived radionuclides offer many advantages relative to Tc$^{99m}$, the very short half-lives of these isotopes impose severe constraints on the design of generator systems. The short half-lives of these isotopes do not allow conventional dispensing and calibration of the dose to be delivered, rather the generators are connected directly to the patient's intravenous line and injected directly into the vein. In addition to the usual requirements of sterility and apyrogenicity, this mode of administration imposes the constraints that the eluent of the generator be physiologically compatible (i.e., approximately isotonic and near neutral pH) and that the generator system be able to provide a sharp bolus of high specific activity radioisotope. Despite these severe restrictions a number of generators have been developed which meet these criteria. Those systems which have reached the most attention include Hg$^{195m}$→Au$^{195m}$, Rb$^{81}$→Kr$^{81m}$, Cd$^{109}$→Ag$^{109m}$, and Os$^{191}$→Ir$^{191m}$. 

Hg$^{195m}$→Au$^{195m}$. The half-life of Au$^{195m}$ (30.5s) would seem to make this isotope the ideal choice for angiography. The generator suffers, however, from serious limitations to routine implementation. Among the most important of these is the short half-life of the Hg$^{195m}$ parent (40 h) which limits the useful life of the generator to about 3 days. Other limitations are also imposed by the parent isotope. Hg$^{195m}$ decays
to the desired Au\(^{195m}\) state only 46% of the time while the remainder of the time it decays to Hg\(^{195}\) (\(T_1 = 9.5\) h) which in turn decays directly to Au\(^{195}\) (\(T_2 = 183\) d, EC) (3). The production of Au\(^{195}\) from this route as well as from Au\(^{195m}\) decay can lead to the injection of significant amounts of Au\(^{195}\) if careful pre-elution procedures are not observed (4).

\(\text{Rb}^{81} \rightarrow \text{Kr}^{81m}\). Although Kr\(^{81m}\) (\(T_1 = 13\) s) decays with a high abundance of 190 keV gamma rays (67%), the short half-life of Rb\(^{81}\) (4.6 h) imposes severe restrictions on production and delivery of the generator. In addition, Krypton is quantitatively eliminated by the lungs thereby precluding studies of the left side of the heart with this isotope.

\(\text{Cd}^{109} \rightarrow \text{Ag}^{109m}\). While the half-life of Ag\(^{109m}\) (39.8 s) is nearly ideal for radionuclide angiography the very long half-life of the Cd\(^{109}\) parent (453 d, EC) imposes extremely low limits on the amount of breakthrough that may be injected without unreasonably increasing the patient absorbed radiation dose. This difficulty is compounded by the very low photon yield of Ag\(^{109m}\) (3.6%) which leads to the requirement that large amounts of Cd\(^{109m}\) be loaded in the generator to obtain a reasonable photon flux.

\(\text{Os}^{191} \rightarrow \text{Ir}^{191m}\). The half-life of the Os\(^{191}\) parent (15.4 d) allows production of a generator with a useful life of approximately two weeks. Ir\(^{191m}\) (\(T_1 = 5\) s) decays with the emission of a 129 keV gamma ray (26%). 65 keV X-rays are also produced (60%) which may be imaged with modern Anger cameras. As Os\(^{191}\) decays by \(\beta^-\) emission, the shielding requirements of the generator are less stringent than for Hg\(^{195m}\) (EC, IT) or Rb (EC, \(\beta^+\)). An additional advantage of this system is its potential use with the multi-wire gamma camera (MWGC) (5). This device allows high resolution images to be obtained at extremely high (up to \(\approx800,000\) cps) count rates using the 65 keV X-rays without interference from the 129 keV gamma rays.

While the half-life of Ir\(^{191m}\) has been described as too short for use in adults (4,6), we have shown that images comparable in quality to those obtained with Tc\(^{99m}\) can be obtained if sufficiently large doses of Ir\(^{191m}\) are administer-