AN OVERVIEW OF THE PRODUCTION, QUALITY CONTROL AND FEASIBILITY OF USING ^{90}Y AS A THERAPEUTIC RADIONUCLIDE

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^{90}Y is increasingly accepted world wide as a radionuclide for in-vivo therapy owing to attractive decay features (T1/2 2.67 d; Eβ max 2.28 MeV) and viable production feasibility in high specific activities. ^{90}Y is most often recommended for treatment of large tumour lesions as the hard β rays are effective in delivering therapeutic dose to large volume. However, possibility of high radiation dose to the critical organs such as bone marrow and kidneys is an important concern that is given due weightage while designing therapy using ^{90}Y.

The best route to avail ^{90}Y for therapy applications is from ^{90}Sr, though neutron actiation of natural ^{89}Y(100% abundance) is feasible. The absorption cross section σ is barely 1.38 b, resulting in low specific activity ^{90}Y which is useful for limited applications. The possibility of obtaining ^{90}Y through a radionuclide generator as the daughter of a long lived parent ^{90}Sr (T1/2 28.9 y) is a major advantage that enables access to high specific activity ^{90}Y. Transporting the ^{90}Y activity to a user institution from a centralized production facility is reasonably feasible and this facilitates its wide spread use. Several generator designs have been developed and reported to access ^{90}Y. Solvent extraction using a chelating molecule in an organic solvent (0.3M HDEHP/n-dodecane), column chromatography using ion exchange resins (cationic as well as anionic; Dowex-50×8; AG 50×16; Aminex-A5) or inorganic exchanger, membrane based separation using chelating ligand impregnated membranes (CMPO in , electrochemical separation are some of the methods reported. Limitations such as elution of ^{90}Y after initial elution of ^{90}Sr, availability of ^{90}Y as a chelated complex which then has to be treated to enable labeling the molecule of interest, possibility of obtaining small quantities of ^{90}Y owing to radiolytic damages to the separation system components, paucity of special automation gadgets for handling the high activities remotely, have been some impediments that have delayed the availability of large scale ^{90}Sr/^{90}Y generators and consequently the wide spread use of ^{90}Y. Further, the bone seeking nature of the long lived ^{90}Sr+2 has resulted in the very low tolerance limits for 90Sr (≤ 74 MBq life time dose), necessitating use of extremely pure ^{90}Y. Considering that a patient may require treatment with ~3.7 GBq ^{90}Y several times in life-time, the permissible levels for ^{90}Sr is well below 10-4%. Hence, a very clean separation of ^{90}Y from ^{90}Sr is essential and it is also essential to ensure the quality of the 90Y using a reliable, real-time quality control technique. Absence of γ rays in both the nuclides, makes it difficult to quantitate the nuclides, particularly when sub-ppm levels of ^{90}Sr has to be measured in ^{90}Y. Very few methods have been reported for QC of ^{90}Y. Measurement of ^{90}Sr levels after decay of ^{90}Y, though simple, does not enable QC before clinical use. Use of specific crown ether based resin for retention of trace levels of ^{90}Sr enables real-time QC, but is cumbersome and expensive.

In this context, the IAEA's CRPs on "The Development of Therapeutic Radionuclide Generators" and it's sequel "Development of radiopharmaceuticals based on ^{188}Re and ^{90}Y for radionuclide therapy" have been highly impactive and heartening. Two types of novel generators, namely the "Supported Liquid Membrane" based generators and the

“Electrochemical Generators” have been developed by us. The latter one, named as “Kamadhenu”, the mythological cow that yields milk eternally, has been developed further as an automated model and ready for deployment. QC of ^{90}Y for quantitative estimation of sub-ppb levels of ^{90}Sr using a novel simple technique of ‘Extraction Paper Chromatography” has also been achieved by us, primarily as a result of the CRP. These important developments have enabled several Member States to start/augment their programs on ^{90}Y based radiopharmaceuticals, which is a significant achievement of a CRP, thanks to the IAEA.