

Therapeutic Nuclear Medicine - Need of the hour

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Nuclear Medicine (NM) is an entrancing medical specialty that uses targeted radioactive tracers (radiopharmaceuticals) to assess organ structure and function and diagnose, stage, assess and treat disease.¹ Since the early days of NM practice, the therapeutic application has been an integral part. Although, apparently, it's a perception that Nuclear Medicine involves only diagnostic approaches. But nowadays, there has been a remarkable evolution in the therapeutic approach. The therapeutic application of NM has proven its utility in the management of a good number of malignant and non-malignant diseases.

When a radionuclide decays, it can emit α (alpha), β (beta), or γ (gamma) radiations, depending on its physical properties. The γ radiation is only photon (no particulate matter) and is used in diagnostic procedures. Whereas α and β radiation are particulate radiation, that has mass and cannot travel as easily as gamma rays. So, when this particulate radiation is trapped in a particular area, they do not travel. Instead, emit their radiation locally. This principle of mechanism is utilized to destroy unwanted cells in a designed way in a particular target organ to produce desired beneficial effects.

The first therapeutic application of Iodine radioisotope (^{131}I) was on March 31, 1941, by Saul Hertz in a patient with thyroid carcinoma at the MGH (Massachusetts General Hospital, USA).² Since then Radioiodine is the most common radioisotope for treating thyroid cancer and thyrotoxicosis globally. Subsequently, many isotopes have been produced and were commercially available for being used for a wide spectrum of indications. The list is exhaustive, but some are worth mentioning. To manage intractable metastatic bone pain, Phosphorus (^{32}P), Strontium (^{89}Sr), Samarium (^{153}Sm), Rhenium (^{186}Re , ^{188}Re) have been developed.³ In a recent review on new radionuclides for bone pain palliation, ^{188}Re appears to be one of the most promising candidates.⁴ For hepatocellular carcinoma (HCC) ^{131}I Lipiodol or ^{188}Re Lipiodol are being used. For pheochromocytoma or paraganglioma, ^{131}I MIBG is very useful. Peptide receptor radionuclide therapy (PRRT) is a form of systemic radiotherapy that allows targeted delivery of radionuclides to tumor cells expressing high levels of somatostatin receptors. The two radiopeptides most commonly used for PRRT, ^{90}Y trium-DOTATOC and ^{177}Lu tetium-DOTATATE, have been successfully employed for more than a decade for the treatment of advanced neuroendocrine tumors (NETs).⁵ ^{177}Lu PSMA is becoming the choice of treatment in castration resistant prostate cancer. In Rheumatology, application of radiopharmaceuticals, eg. ^{90}Y trium silicate/citrate, ^{169}Er bium citrate and ^{188}Re -Sn colloid⁶ in the joint spaces to promote effective radio-synovectomy have been widely used in many countries.

The benefits of therapeutic application of Radiopharmaceutical are immense. It is a non-invasive procedure. Mostly only single dose/ injection is required for the desired effect in outpatient

settings. Increased patient compliance as patients can leave the hospital straightforwardly after the procedure is complete. In addition, there is extremely less possibility of unwanted side effects as the particulate radiation discharges radiation to only a brief distance after the taking-up of radiopharmaceutical by target cells.

In Bangladesh, therapeutic Nuclear Medicine started way back in 1980 in NINMAS (National Institute of Nuclear Medicine and Allied Sciences). Later it has disseminated to all the government-run NM institutes through BAEC (Bangladesh Atomic Energy Commission). Till now a vast number of thyroid carcinoma and thyrotoxicosis have been treated with ^{131}I in the country. We have also extensive experience with ^{90}Sr ophthalmic applications for Pterygium and basal/squamous cell carcinoma of the conjunctiva. A few metastatic bone palliations were also given with ^{32}P . But in the overall scenario of the country, we are lagging in the field of therapeutic approaches of NM, unlike the diagnostic NM which has developed immensely.⁷

Till now no private institutions have started these facilities in the country, whereas the public facilities are not able to cope with the load of the patients. Evercare Hospital Dhaka (EHD) has the skilled manpower and the professional expertise. We think the management would come forward to start this facility. To begin with, ^{131}I is a cheap easily available isotope for successful therapy of thyroid patients. No elaborate infrastructure either needed. According to the government regulations, treating thyrotoxicosis is completely an OPD procedure and even thyroid carcinoma can be managed without admission by a low-dose regimen.

Another promising isotope in the EHD setting can be is ^{188}Re . It is a high energy (2.12 MeV) beta-emitting radioisotope with a short 16.9 h physical half-life, which has been shown to be a very attractive candidate for use in therapeutic nuclear medicine. The high energy is sufficient to penetrate and destroy targeted abnormal tissues. In addition, the low-abundant gamma emission of 155 keV (15%) is efficient for imaging and for dosimetric calculations. ^{188}Re and technetium-99m exhibit similar chemical properties and represent a ‘theragnostic pair’.⁸ Most of all, it can be available onsite from $^{188}\text{W}/^{188}\text{Re}$ generator, in a convenient way.⁹ Because of its physical properties, ^{188}Re is suitable for labeling peptides, antibodies, and colloids to form radiopharmaceuticals. The most common forms of ^{188}Re radiopharmaceuticals include ^{188}Re HEDP (hydroxyethylidenediphosphonate) for osseous metastases, DMSA (dimercaptosuccinic acid) for medullary carcinomas, ^{188}Re HDD Lipiodol is also utilized for the treatment of hepatocellular carcinomas (HCC).⁸ ^{188}Re microspheres for selective intra-arterial radionuclide therapy (SIRT) in patients with HCC is also being successfully used.¹⁰ So, with a single generator, which can last for about a year, it is possible to treat multimodality of diseases.

With the ongoing improvement of the socio-economic parameters in Bangladesh, the availability of newer technologies is increasing. Nevertheless, affordability is increasing too among the general population. The medical sector has shown significant improvement in its ability to provide better health facilities in recent days. As being the first & only JCI accredited hospital in the country, it is expected that EHD to be at the forefront of providing the recent advancements for patients’ greater benefit.

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