

Nuclear medicine: Beyond imaging

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“Nothing endures but change” said Heraclitus in 500BC and it is much more pertinent to medical field as we are having new diseases, new treatment guidelines, technological advancements to aid diagnosis of the diseases and extensive research to find cure for many diseases every other day. Oncology is one of the field in medicine where research is going on in fast pace with special emphasis on early diagnosis of cancer and in finding cure for various cancers. If medical oncology, surgical oncology and radiation oncology are pillars of oncology, diagnostic branches like pathology, biochemistry, nuclear medicine and radiology form the foundation.

Nuclear medicine has come a long way, from a rectilinear scanner in 1940s to modern day advanced digital PET/CT and PET/MRI scanners. PET/CT was a technical evolution and clinical revolution in the field of oncology. PET/CT uses a small amount of radio-tracer where positron emitting radionuclides are tagged with specific carrier molecules which aid in diagnosing cancer, to know the extent of spread of cancer and to monitor response for treatment.

While imaging is the work horse of any department of Nuclear medicine, treating various diseases using radionuclides/labelled radionuclides forms 10 to 20 per cent of the total work flow. It was in 1941, Saul Hertz gave a patient of hyperthyroidism, the first therapeutic dose of mixture of iodine-131/ iodine -130. Not only, this marked the first therapeutic use of radio-iodine, but also the use of targeted radionuclide therapy to demonstrate the fundamental principles of both molecular nuclear medicine and Theranostics.

In 1951-The US Food and Drug Administration (FDA) approved sodium iodide 1-131 for use with thyroid patients. It was the first FDA-approved radiopharmaceutical. Since then I-131 therapy is routinely used in treating Graves' disease, toxic multinodular goitre, autonomously functioning thyroid nodule and differentiated thyroid cancers. Beta rays emitted by I-131 have cell killing power. I-131 gets specifically localised in thyroid tissue and destroy the cells.

75 years later, an era of rebirth for radionuclide therapy was found, with the introductions of alpha emitter, ^{223}Ra dichloride for treatment of bone metastases and beta emitter ^{177}Lu -labeled agents for treatment of both neuroendocrine tumours and prostate cancer. The importance of personalised medicine has been growing, mainly to tailor treatment for each patient, to avoid unnecessary and expensive treatments.

In Nuclear medicine, both for diagnostics and therapy, Theranostics approach is an established tool for specific molecular

targeting. The visualisation of potential targets through imaging can help predict if a patient will benefit from a particular treatment. Thanks to the ongoing research, development of newer radiopharmaceuticals and diagnostic techniques, the use of theranostic agents has been continually increasing.

The use of ^{177}Lu -labeled agents opens up the potential for new theranostic applications, where, much as with radioactive iodine in the management of thyroid disease, the same agent can be used for both diagnostic imaging and therapy. Also labeled radionuclides are used in treating bone metastases- for pain palliation, radiosynovectomy for arthritis, in refractory cases of lymphomas and TARE for liver tumours. Newer molecule FAPI (Fibroblast activation protein inhibitor) is showing promising results in animal studies and if translated from bench to bed side, has a huge potential as a theranostic agent in various cancers.

The combination of targeted cancer imaging and therapy is a considerable contribution to personalised medicine and may play an increasingly important role in the future. With persistent scientific vision, courage and persistence, the field of Nuclear medicine is expected to spread its horizon in the field of therapy, beyond imaging.

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