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Dosimetry: an under Used Aspect of Nuclear Medicine Practice in Bangladesh

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Thyroid gland and radioactive iodine has been pivotal to the development of Nuclear Medicine all over the world including Bangladesh. It is interesting to note that in the current excitement over theranostics, the concept of personalized molecular medicine was preceded by radioiodine for diagnosis and therapy of thyroid diseases more than half a century ago.

Personalized medicine is now the core concept of modern medicine and has broadened to include not only radionuclide therapy of cancers but also to the image-guided therapy of other non-communicable diseases such as carotid or coronary artery stenosis (1).

Nevertheless the therapeutic use of radioiodine in thyroid disease continues to reign. Especially in Bangladesh the bulk of nuclear medicine therapy is still mostly confined to the treatment of hyperthyroidism and thyroid cancer with radioiodine.

In hyperactive thyroid disease, a fixed dosage regimen is usually followed with the assumption that all patients will ultimately become hypothyroid. However, studies have shown that administration of a calculated dose regime with lower dosage can result in lowered hypothyroid state (2). The low dose approach therefore appears logical especially in Bangladesh where so many patients fail to comply with lifelong thyroid supplement.

In differentiated thyroid carcinoma, the optimal $_{131}$I activity for remnant thyroid ablation and metastatic disease still remains controversial. The trend is towards higher ablation dose (>3700 MBq, 100 mCi) for higher ablation rate. Two randomized multicenter studies have shown that low dose $_{131}$I (1110 MBq, 30 mCi) were able to produce equally satisfactory ablative outcome, compared to high ablation dose. This is applicable in low to intermediate risk patients for convenience of follow up with Tg and diagnostic $_{131}$I WBS. However for patients with suspicious residual microscopic disease or more aggressive tumor histology or high recurrence risk, a high dose (>3700 MBq) of $_{131}$I is recommended for the first RAI treatment for the purpose of reducing the risk of recurrence and/or mortality (3).

Radioiodine-131is a remarkable isotope that simultaneously emits beta rays (for therapy) and gamma rays (for imaging). After administration into the body, radioiodine is rapidly taken up by the thyroid cells and the effect of beta particles is restricted within the gland. Other than the thyroid, normal biodistribution of iodine occurs in the salivary glands, stomach, intestines, urinary tract and bladder. These organs therefore receive relatively high dose during therapy. High energy gamma-ray emission, also contributes to the radiation dose. Thus untoward short-and long-term effects of radiation on the treated patient are sialadenitis, lacrimal duct obstruction, red marrow suppression, radiation pneumonitis, breast radiation and secondary neoplasms.

Absorbed dose to all significant tissues can be estimated and excess toxicity avoided to some extent by applying radiation dose calculations. The MIRD (Medical Internal Radiation Dose) system for nuclear medicine dosimetry has been used for many years to standardize radiation dose calculations in nuclear medicine. However in radionuclide therapy, different approaches need to be considered that include patient-specific geometry and biokinetics. With the advancement of nuclear medicine equipment, quantitative imaging is a major part of current dosimetry and treatment planning workflow. Particularly tomographic methods (SPECT/ CT and PET- CT) would permit the determination of the activity distribution in a patient at given time points. In Bangladesh, Quadir et al has shown that a simple Planar and SPECT gamma camera image counts can be used to calculate radioactivity in an organ. (4). This information can play a very significant role in evaluating image based patient specific dosimetry in radionuclide therapy in the country.

Currently however dosimetry and treatment planning in radioiodine therapy in Bangladesh is an exception rather than a rule. This is due to the complicated and highly specialized nature of radiation dosimetry. Dedicated effort are therefore needed to design and establish a workable protocol that can be easily incorporated into therapeutic procedures. It is all the more important since the National Institute of Nuclear Medicine & Allied Sciences in Dhaka is planning to establish Theranostics in the near future. This will involve the use of several radiopharmaceuticals other than radioiodine, such as 90Y, 177Lu and 68Ga with potential for toxicities to the bone marrow and the kidneys. Consequently a standardized and refined dosimetric protocol at par with Accredited Dosimetry Calibration Laboratories (ADCLs) would be mandatory.

In conclusion, targeted therapy must involve proper planning that will consider the safety and the efficacy of a particular radiopharmaceutical to be used. Standardized dosimetry to study biokinetics in normal tissues and tumors should be an integral and mandatory part of therapeutic nuclear medicine.

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