Radiation protection in therapy with radiopharmaceuticals

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Introduction

Radiation protection in medicine covers in principle, medical exposure, occupational exposure, and public exposure in association with various clinical circumstances. Medical exposure involves not only patients but also their comforters and carers, and volunteers in biomedical research. Medical exposure of patients has unique features that affect how the fundamental principles are applied [1]. Application of dose limits, which is one of the fundamental principles of radiation protection elsewhere, is not undertaken in medical exposure. This is because such dose limits would often do more harm than good in the course of treating patients. Two fundamental principles of general radiation protection, justification and optimization, apply in medicine in a different way. Justification in radiation protection of patients is unique in that the very same subject enjoys the benefits and suffers the risks associated with a radiological procedure. Optimization of protection for patients is also unique in that radiation therapy gives intentional radiation for the purpose of treatment, and diagnostic procedures give the benefit and the risk to the same subjects. Therapy with radiopharmaceuticals, namely radionuclide therapy (RNT), requires deliberate radiation protection standards because it uses unsealed radionuclides and gives therapeutic radiation doses in humans.

From Radionuclide Therapy to Theranostics

The use of radiopharmaceuticals for therapy using novel radionuclides, including alpha emitters, compounds and probes, has been increasing for the treatment of various tumors, that is, RNT, in connection with which “theranostics” has been established. Theranostics means a method of combining diagnosis and therapy and enhancing the efficacy and safety of procedures to an individual patient. In nuclear medicine, theranostics usually refers to a combination of imaging and RNT in oncological nuclear medicine [2]. Conventional imaging and treatment of iodine-131 therapy for differentiated thyroid cancer, and Zevalin therapy with indium-111 antibody and yttrium-90 antibody to B-cell non-Hodgkin's lymphoma can be examples of theranostics.

Dosimetry-guided Personalized Therapy

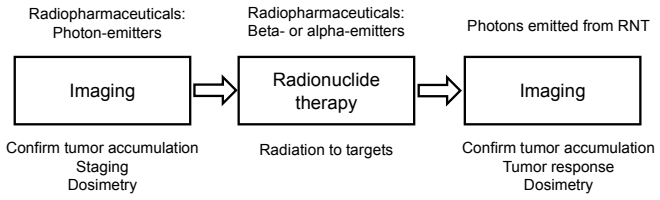
As theranostic procedures currently attracting attention in nuclear medicine, somatostatin receptor imaging for neuroendocrine tumors and PRRT (peptide receptor radionuclide therapy) have attracted attention, and a large-scale clinical trial of Lutetium-177 Dotatate against neuroendocrine tumors has been conducted [3]. Also, imaging with Ga-68 labeled ligands targeted to PSMA (prostate specific membrane antigen) expressed in prostate cancer and RNT with Lu-177 labeled ligand are currently being conducted mainly in Europe. In addition, alpha-emitter Ac (actinium)

-225-labeled PSMA ligand has been reported to have a dramatic therapeutic effect on advanced prostate cancer [4]. In these procedures, dosimetry based on imaging is critical in guiding subsequent therapies. The European directive on basic safety standards (Council directive 2013/59 Euratom) mandates dosimetry-based treatment planning for radiation therapies including radiopharmaceutical therapies. The directive comes into operation February 2018. Dosimetry-guided practices will have significant implications for the evolution of RNT (Figure 1).

Conclusions

RNT combined with imaging and dosimetry is undergoing a significant expansion, and such dosimetry-based treatment planning is already in place. The mandated individualization is likely to improve the effectiveness of the treatments [5].

Figure 1. Radionuclide Therapy guided by Imaging and Dosimetry



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