Educational topics in specialized training for BNCT staff

Table 1 lists operations in the area of medical physics relating to BNCT. The list includes medical physics topics anticipated in the effort to develop more sophisticated care and a variety of devices to address care-related issues. We have also proposed tomographic images of hydrogen and nitrogen, which have not been targeted in conventional radiation treatment, as a topic.

In addition to general knowledge in the areas of medical physics, radiation biology, radiation oncology, pharmaceutical science, and nuclear medicine, staff specializing in BNCT must exhibit specialized and basic knowledge of the following in their capacity as medical physics specialists:

1. Interactions of neutrons in the body

(nuclear transmutation, scattering, and capture reactions as well as methods of neutron spectra detections and of neutron-gamma discrimination detection)

2. Irradiation effects in the BNCT irradiation field

(radiation quality, dose evaluation, and tissue reactions)

3. Effective dose distribution optimization planning

(radiation quality, dose distribution, ^{10}B agent distribution, intra- and extra-cellular concentrations, and the cell cycle as well as dose-volume histogram (DVH) creation and the concepts of probability of tumor control and complication development)

4. Safe handling of, and protection from, leakage radiation, primarily in neutron form

Additionally, training in how to understand and use FBPA PET data from a nuclear medicine perspective is essential in effective dose distribution optimization planning, making it an important priority. Furthermore, medical physics specialists will need to possess a sufficient level of understanding and skill to develop more sophisticated and advanced forms of BNCT in the future while monitoring the general development of radiation treatment. Because practical training in close partnership with BNCT work in the field is an important means of mastering this broad body of knowledge, it will be necessary to plan to address educational topics that correspond to these areas outside of classroom work.

The topics listed in Table 1 describe coursework and practical training to address these requirements.

Table 1. BNCT Tasks

Care-related topics	Related equipment	Medical physics topics (evaluation and development priorities)
BPA concentration judgment	FBPA PET and cutaneous layer PGA	PET system and measuring instrument development
Imaging for planning purposes	CT, MRI, FBPA PET	H, B, and N density imaging
Dose distribution planning	SERA, JCDS optimization, reaction projection	DVH (solid volume, differentials, etc.), NTCD, TCD calculation methods (interactive), inhomogeneity correction (regenerative domain), radiation quality (drug concentration dependent), tissue characteristics
Irradiation position determination	Devices and instruments for immobilizing patients	Immobilization of patients in specific positions as if their movements have been frozen in time (without constraints, movable/automatic restoration)
Irradiation instrument determination	Collimator, shielding	Systems for verifying and measuring conditions for optimization of dose distribution
Final imaging	CR	Collimator/irradiation field, degree of closeness, level/rotating
Injection of pre-treatment	Blood concentration, transfusion systems	Real-time evaluation of concentration
Irradiation room transport	Transport systems	Final position immobilization and final imaging, staff protection
Injection of post-treatment and start of irradiation	Monitoring systems	Measurement of irradiation control systems (presets, etc.) Irradiation QA, dose control, real-time dose evaluation, monitor evaluation systems (QA/QC)
Completion of irradiation and irradiation room transport	Discharge systems	Staff protection

2. Principal Medical Physics Topics

Classroom topics

- ^{10}B measurement (FBPA PET concentration measurement, ICP measurement, PGA measurement, internal concentration measurement)
- Neutron/gamma ray discrimination and measurement; measurement of 4 types of radiation quality
- Proposal of effective dose distribution optimization plans (image diagnostics, optimization, interactive approach)
- Evaluation of the effects of the irradiation field (drug concentration/movement and irradiation dose)
- Development of higher-quality irradiation fields (collimator structure and irradiation field evaluation)
- Positioning and immobilization (close fit with collimator and patient comfort)
- Quality assurance (reliability, safety, soundness, durability)
- Safety measures (equipment, exposure)

Practical training topics

- Measurement of irradiation field (dose) and radiation quality and verification of effective dose distribution optimization plans
- Plan evaluation and measurement, verification of shielding equipment plans and safety measures
- Measurement of drug accumulation
- Site work such as immobilization of patient position

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