NAKAMURA-2: Treatment facility design for an accelerator-based BNCT system in National Cancer Center Hospital

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An accelerator-based BNCT system employing a solid-state lithium target was installed in National Cancer Center Hospital (NCCH), Tokyo, Japan. The system was manufactured by Cancer Intelligence Care Systems, Inc., Tokyo, Japan. In NCCH, a clinical trial using the system and a boron-10 compound, which is provided by STELLA PHARMA CORPORATION, has been conducted since November, 2019. The first patient was treated on November, 2019, and it was the first treatment for human using the accelerator-based BNCT system with the Li target in the world. Three patients has been treated by end of January, 2020. This study introduces a part of the treatment facility and the treatment procedure in NCCH.

The facility can be divided into three sections (the system, a procedure area before/after BNCT, and a treatment room). The system consists of a proton linear accelerator, transport devices for the accelerated protons, a Li target, and a beam shaping assembly. In the system, the vertical neutron beam is adopted for BNCT. The procedure area has a computed tomography (CT) device for a treatment planning and off-line IGRT (including simulation space), a control room for the CT device and the system, an inductivity coupled plasma optical emission spectrometer for measuring the boron density in blood of the patient, some detectors and phantoms for performing the quality assurance/control (QA/QC), a treatment planning system (TPS), and a waiting room. In the control room, the number of required neutrons for BNCT is controlled by the number of protons delivered to the Li target in the system. In the waiting room, drip for the compounds is performed before BNCT and the patient condition is confirmed after BNCT. The treatment room equips four cameras and a percutaneous oxygen saturation monitor to confirm the patient condition during BNCT. The treatment room also equips a treatment couch which can shift freedom on 5-axis in order to achieve the off-line IGRT. It is noted that the 5-axis shift is sufficient for the system since the neutron beam is isotropically emitted against perpendicular to the beam axis.

Using those three sections, BNCT can be performed. There are many work in each related occupation (radiation oncologist, medical physicist, radiation technologist, and nurse) before and after BNCT. Time schedule on the treatment day is especially busy. In NCCH, it spends approximately 4 hours to perform the one treatment in each occupation. Figure 1 shows a part of the process map on the treatment day before BNCT.

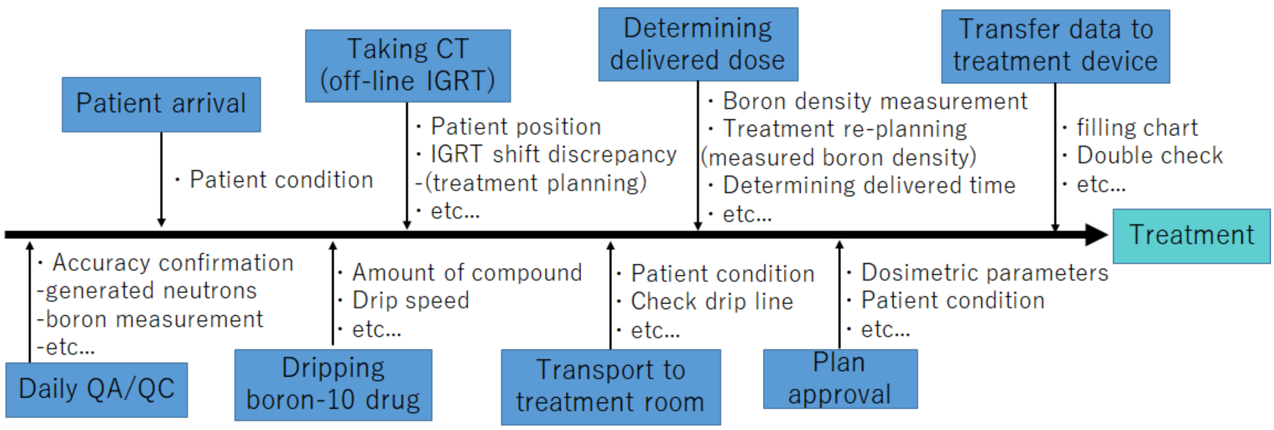

Fig.1: Outline of the process map on the treatment day before BNCT