Primary and secondary brain tumors are a constant challenge for the modern medicine. Introduction of ever more advanced forms of cancer treatment improves survival but good functioning in this group of patients remains limited. Radiation therapy (RT) is one of effective and safe methods of treating intracranial tumors. During this therapy, high doses of ionizing radiation are applied to the cancerous tumor, with maximum protection of the healthy tissues, using highly specialist equipment allowing for management and control of this treatment method. Tissue and organ sensitivity to ionizing radiation differs and depends on numerous factors and the same dose of radiation may produce different effects in particular structures of the central nervous system (CNS). However, the effect of ionizing radiation is not limited to the cancerous tumor alone. It can also affect the surrounding healthy tissues and lead to adverse effects like a decrease in the cognitive function, including memory deterioration or physical function impairment, which result from i.a. nerve cell death or healing processes within irradiated tissues. One of brain structures most sensitive to ionizing radiation is the limbic system, especially the hippocampus, because it is here that the postnatal neurogenesis takes place via neural stem cells (NSC), which are a self-renewing population of precursor cells. The formation of new, increasingly complex neural networks is of key importance for the processes of learning and memorizing, or associative thinking, whereas lowered NSC function is reflected in function impairment in brain cancer patients treated with radiation therapy. To date, there have been no studies that would thoroughly examine the impact of different CNS radiation therapy techniques on the cognitive function, potential neuroplasticity markers or blood-brain barrier damage in brain tumor patients. At the same time, there are few studies on the application of modern CNS radiation therapy techniques with a concomitant use of neurocognitive combination therapies or physical exercise, and their impact on the CNS function.

The aim of the proposed study is to assess the impact of selected radiation therapy techniques: intensity-modulated radiotherapy (IMRT), whole brain radiotherapy (WBRT), and CyberKnife (stereotactic radiosurgery - SRS) on the processes regulating cognitive and physical function in patients with primary (Group III and IV, WHO, 2016) and secondary (metastatic) CNS tumors. The secondary objective, on the other hand, is the analysis of the effect of selected forms of neurorehabilitation on the parameters studied. The study will be a prospective clinical trial conducted in a group of 150 patients. Patient evaluation will be carried out before RT, after RT, during a follow-up visit - 3 months after RT, and finally after 6 months.

The following study methods will be used: analysis of the blood-brain barrier permeability markers including exact connection proteins, markers confirming neuroplasticity of the brain, as well as cerebral secretory activity, and onco- and anti-neuronal antibody activity, brain structure analysis (MRI) and its modification, i.e. volume testing (volumetry) of selected brain structures, and assessment of cognitive and physical function of the patients.

The study will be a part of the search trend aiming to explain the mechanism of the formation of cognitive-behavioral disorders in humans based on the most fundamental principles governing information processing in CNS as well as the impact of neoplasia and ionizing radiation on selected brain structures and functions. No such studies have been performed to date and literature data on this subject matter are inconsistent and ambiguous.

The results of the proposed study might become a starting point for the formulation of new guidelines on the level of physical activity or cognitive exercise in patients treated with CNS radiation therapy due to primary and secondary tumors in order to reduce, if possible, the risk of cognitive-behavioral deficits.

We expect that the proposed intervention study will allow for extending knowledge on the recommended neurorehabilitation values in order to prevent negative processes impairing neuroplasticity in patients with CNS tumors treated with RT.