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Abstract Collection

Nuryanti1, Mudjiono, Elok Satiti Amitayani, Nur Hasanah, Nurlaila, Ewitha Nurulhuda, Rizky Firmansyah Setya Budi, Sufiana Solihat, Anis Rohanda, Jupiter Sitorus Pane, Imam Bastori. *Cost-Benefit Analysis of G.A. Siwabessy Reactor Revitalization for I-131 Production*, Tri Dasa Mega, 27 (1), 1.

One of the IAEA expert team's recommendations in the peer review of three Indonesian research reactors in 2022 was to increase their utilization, especially for the production of radioisotopes and radiopharmaceuticals, through a revitalization program and operating permits extension, such as for the G. A. Siwabessy Multipurpose reactor (RSG-GAS). One of the radioisotopes widely used in the health sector is I-131. The existing I-131 domestic demand is recorded at 2,869.35 Ci per year and is projected to increase along with cancer prevalence. Imports fully meet the current demand at quite high prices. Therefore, the RSG-GAS and its supporting facilities revitalization project and post-revitalization have strategic value for the national pharmaceutical industry independence, which could be started with the I-131 production. The revitalization requires large funds, so the benefits are expected to be greater than the investment. This study aims to conduct a cost-benefit analysis of the revitalization project plan. Two scenarios were formulated, such as the I-131 production scenario ('with the project') and the counterfactual scenario ('without the project'). The 'with the project' scenario was carried out for reactors with varied operating power (5 MW, 15 MW, and 30 MW). The results show that with the current rate for Non-Tax State Revenue (PNBP) tariff, the 'without the project' scenario is unfeasible, indicated by a negative net present value (NPV) of IDR -114,32 billion. The 'with the project' scenario is also unfeasible at all reactor capacities, indicated by negative NPV (IDR -418.17 billion at 5 MW; IDR -540.72 billion at 15 MW, and IDR -722.51 billion at 30 MW). Negative incremental NPV values relative to their counterfactual scenario also emphasize the unfeasibility of this scenario (at IDR -303.85 billion at 5 MW; IDR -426.40 billion at 15 MW, and IDR -608.19 billion at 30 MW). Sensitivity analysis of I-131 PNBP tariff for 'with the project' scenario under 15 MW RSG-GAS power shows that the project will be feasible at a minimum PNBP tariff of IDR 21,000 per mCi.

Keywords: Cost-benefit analysis, Revitalization, G. A. Siwabessy multipurpose reactor, I-131 radioisotope

Ariana Irawati, Beta Nur Pratiwi, Subur Pramono, Yohannes Sardjono, Isman Mulyadi Triatmoko, Gede Sutresna Wijaya, Heru Prasetio, Nur Rahmah Hidayati, Nunung Nuraeni, Syarifatul Ulya, Zuhdi Ismail. *Dose Optimization and Irradiation Angle Analysis for Advanced Liver Cancer Using PHITS Version 3.341*, Tri Dasa Mega, 27 (1), 17.

Based on 2022 statistics from the World Health Organization (WHO), liver cancer ranks as the 3rd leading cause of cancer-related mortality worldwide, claiming approximately 750,000 lives annually. X-ray therapy has demonstrated effectiveness in providing local-regional control, making it a potential treatment modality for liver cancer. This study aims to determine the optimal irradiation direction for advanced-stage (C) Hepatocellular Carcinoma (HCC) using radiation therapy. To simulate the X-ray radiation transport process in the human body, a phantom model has been developed using various materials that mimic body tissues with the PHITS (Particle and Heavy Ion Transport code System) program Monte Carlo method. The study revealed that the irradiation direction greatly affects the irradiation time required to achieve the prescribed dose threshold. X-ray therapy dose analysis evaluates the number of fractions required to achieve a lethal dose to cancer cells while minimizing the dose to healthy surrounding cells. The irradiation direction was varied at 0°, 45°, and 90° to find the optimal angle that results in the shortest irradiation time. By evaluating the number of fractions needed to reach the lethal dose limit for cancer cells, the 45° or Right Anterior Oblique (RAO) irradiation direction is the most optimal direction with a total of 16-25 fractions with an irradiation time of 2.01 minutes/fraction and a dose to cancer of 1.94 Gy/fraction. These findings could contribute to the refinement of treatment protocols, which potentially improve outcomes for patients with advanced liver cancer.

Keywords: Liver Cancer, HCC, Fraction, Dosimetry, Radiotherapy, X-Ray Therapy, PHITS Version 3. 341

Laili Rochimah, Subur Pramono, Beta Nur Pratiwi, Yohannes Sardjono, Gede Sutresna Wijaya, Isman Mulyadi Triatmoko, Nunung Nuraeni, Heru Prasetio, Nur Rahmah Hidayati, Syarifatul Ulya, Zuhdi Ismail, *Optimizing Boron Dose for Cervical Cancer Therapy Using BNCT and PHITS Simulations*., Tri Dasa Mega, 27 (1), 29.

Cervical cancer, with approximately 569.000 new cases annually, ranks as the fourth most prevalent malignancy among women worldwide. This high incidence rate significantly contributes to its position as one of the leading causes of cancer-related mortality worldwide. Boron Neutron Capture Therapy (BNCT), a form of radiotherapy based on the neutron capture principle, utilizes boron-10 as a targeted agent for destroying cancer cells. In this study, the geometry of cervical cancer tissue and surrounding healthy organs was simulated under neutron irradiation, using boron concentrations of 100, 120, and 140 µg/g from the left-lateral and posterior-anterior directions. This study aimed to determine the optimal boron concentration and irradiation time for effective eradication of stage IIIA cervical cancer while minimizing side effects. The Particle and Heavy Ion Transport Code System (PHITS) was employed to model particle transport and dose distribution. Simulation results indicate that the total dose rate required for tumor eradiction in the 8.68 x 10^2 *Gy/s Gross Tumor Volume (GTV) is achieved at a boron concentration of 140 µg/g, with minimal impact on surrounding tissues, and an optimal irradiation time of 18 minutes 22 seconds from the left-lateral direction*

Keywords: BNCT, Dosimetry, Cervical, PHITS

Alfiyah Sulistiawati, Subur Pramono, Beta Nur Pratiwi, Gede Sutresna Wijaya, Isman Mulyadi Triatmoko, Yohannes Sardjono, Nunung Nuraeni, Heru Prasetio, Nur Rahmah Hidayati, Syarifatul Ulya, Zuhdi Ismail, *Dose Analysis of Brain Cancer Therapy with Boron Neutron Capture Therapy (BNCT) using PHITS V.3.33* ., Tri Dasa Mega, 27 (1), 39.

One type of brain cancer, glioblastoma (GBM), attacks glial cells and belongs to the glioma category. While MRI imaging is mainly used to create geometric images of brain cancers, Boron Neutron Capture Therapy (BNCT) was known for destroying cancer cells in a single treatment or cleavage session. On the other hand, the PHITS (Particle and Heavy Ion Transport Code System) code can help in radiotherapy plans using model simulation. This study aims to analyze the absorbed dose by each organ and determine the shortest irradiation time for each beam direction. This study used 90° (Left-Lateral) and 0° (postero-anterior) angular orientations in combination with varied boron concentrations of 40 µg/g, 80 µg/g, 100 µg/g, and 150 µg/g. The results showed that this study's 90° angle orientation (L-LAT) with a boron concentration of 150 µg/g was optimal. The shortest exposure time of 33.18 minutes resulted in the absorbed doses of 1.77 Gy for the skin, which is below the dose tolerance limit of 2 Gy; the spinal organ absorbs 5.43 Gy, below the tolerance limit of 14 Gy; and the brain receives 2.38 Gy, below the tolerance limit of 3 Gy.

Keywords: Brain cancer, BNCT, Dosimetry, PHITS, L-LAT.

Tri Nanda Febriansyah, Beta Nur Pratiwi, Subur Pramono, Yohannes Sardjono, Isman Mulyadi Triatmoko, Gede Sutresna Wijaya, Heru Prasetio, Nur Rahmah Hidayati, Nunung Nuraeni, Syarifatul Ulya, Zuhdi Ismail, *Dose Analysis of Prostate Cancer Therapy with X-Ray Therapy using PHITS Program Version 3.341*, Tri Dasa Mega, 27 (1), 49.

According to statistics from the WHO, in 2022, prostate cancer was ranked 4th out of 15 cancers that cause the highest deaths in the world. Prostate cancer forms in the prostate gland cells. Most prostate cancers are slow-growing and unlikely to spread, but some can grow faster. The position and dimensions of prostate cancer are visualized with MRI so that treatment methods can be performed with X-ray therapy through LINAC. This study used PHITS to simulate X-ray therapy using a voxel or phantom model. The phantom used was based on an American adult male from the ORNL Phantom. The treatment was simulated using three irradiation directions of 0°, 45°, and 90°. The results stated that 33-35 fractions were required to achieve a total 65-70 Gy dose. The more optimal irradiation direction is at 45 degrees, with 1.66 Gy per fraction on the skin and 1.99 Gy per fraction on cancer cells, with a total absorbed dose of 65.8-69.8 Gy.

Keywords: Prostate Cancer, Dosimetry, Radiotherapy, X-Ray Therapy, PHITS V. 3. 341

Salis Raidalliani, Subur Pramono, Beta Nur Pratiwi, Yohannes Sardjono, Gede Sutresna Wijaya, Isman Mulyadi Triatmoko , Nunung Nuraeni, Heru Prasetio, Nur Rahmah Hidayati, Syarifatul Ulya, Zuhdi Ismail. *Dose Analysis of Esophageal Cancer Therapy with Boron Neutron Capture Therapy (BNCT) Using PHITS Version 3.33.*, Tri Dasa Mega, 27 (1), 59.

Based on statistics from the World Health Organization (WHO) in 2022, esophageal cancer ranks 7th out of 15 types of cancer that cause the highest number of deaths in the world. Boron Neutron Capture Therapy (BNCT) is a proven therapeutic method for treating esophageal cancer, as it delivers high doses of radiation selectively to cancer cells while minimizing damage to healthy tissue. This research was carried out to determine the dose absorbed by esophageal cancer, as well as to determine the optimum boron concentration, irradiation time, and irradiation direction to kill cancer utilizing the Particle and Heavy Ion

Transport Code System (PHITS) software version 3.33. PHITS simulates BNCT therapy on esophageal cancer with the Monte Carlo method. According to the existing literature, no studies have explored esophageal cancer treatment using BNCT therapy in conjunction with Monte Carlo method simulation with PHITS. The results showed that the irradiation direction of 0^° with a boron concentration of 150 μ*g*/*g* produced a lower absorbed dose and was more efficient in irradiation time. The shortest irradiation time obtained was 31 minutes with a dose absorbed by the esophagus of 2.77 Gy, while the dose absorbed by the skin was 1.78 Gy.

Keywords: Esophageal Cancer, BNCT, PHITS. Dosimetry.

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