Journal of Medicine and Life Science

eISSN: 2671-4922

Journal of Medicine and Life Science Vol. 21, No. 3, 138-140, September 2024
https://doi.org/10.22730/jmls.2024.21.3.138

Letter

Implementing a new cyclotron facility: challenges and opportunities for advancing PET/CT imaging in an isolated island setting

Ji Young Lee, Hee-Sung Song

Department of Nuclear Medicine, Jeju National University Hospital, Jeju National University College of Medicine, Jeju, Republic of Korea

Key words: Cyclotrons, Positron emission tomography computed tomography, Radiopharmaceuticals

Received: August 5, 2024
Revised: August 14, 2024
Accepted: September 4, 2024

Correspondence to
Hee-Sung Song
Department of Nuclear Medicine, Jeju National University Hospital, Jeju National University College of Medicine, 15 Aran 13-gil, Jeju 63241, Republic of Korea
Tel: 82-64-717-1301
Fax: 82-64-717-1309
E-mail: heesung119@gmail.com

Positron emission tomography/computed tomography (PET/CT) has revolutionized medical diagnostics by providing detailed insights into physiological and pathological processes at the molecular level. This hybrid imaging modality has become essential in oncology, neurology, and cardiology, enabling early diagnosis, accurate staging, and precise treatment monitoring. The production of short-lived radioisotopes, primarily fluorine-18 (F-18), typically generated in a cyclotron and rapidly incorporated into various radiopharmaceuticals, is a key component of PET/CT imaging. The short half-life of F-18 (approximately 110 minutes) necessitates local production, which presents remarkably logistical challenges in geographically isolated areas. Recognizing this, the South Korean government, through the Ministry of Education, Science and Technology, initiated a program to establish regional cyclotron centers, aimed at ensuring equitable access to advanced medical imaging nationwide. This initiative led to the establishment of seven centers, including facilities at Seoul National University Bundang Hospital, Kangwon National University Hospital, Jeonbuk National University Hospital, Kyungpook National University Hospital, Chosun University Hospital, Pusan National University Hospital, and Jeju National University Hospital (JNUH).[1,2] This article is exempt from IRB review because it is a letter about hospital equipment and facilities that does not involve patient clinical information.

In October 2009, JNUH became part of the select group of medical institutions in South Korea with the installation

of the Korea Institute of Radiological and Medical Sciences (KIRAMS)-13 cyclotron, developed by KIRAMS and initially managed by Samyoung Unitech Co., Ltd (Daejeon, Korea). The installation was funded by a combination of government support (800 million won) and hospital budget (4.8 billion won). The cyclotron enabled local production of F-18 for synthesizing fluorodeoxyglucose (FDG) and, more recently, F-18-N-(3-fluoropropyl)-2β-carboxymethoxy-3β-(4-iodophenyl) nortropane (FP-CIT) for Parkinson's disease diagnosis. This development considerably improved healthcare access for the residents of Jeju Island, eliminating the need for them to travel to the mainland for PET/CT scans. However, after 16 years of operation, the KIRAMS-13 cyclotron at JNUH is encountering critical issues that threaten its continued viability. While aging equipment is an inevitable outcome, proper maintenance and repairs can extend a cyclotron's lifespan. Unfortunately, in 2016, Samyoung Unitech Co., Ltd. relinquished its rights to installation, maintenance, and repair services for the KIRAMS-13. Since then, JNUH has faced a critical shortage of specialized technical support, limiting its ability to perform routine maintenance, address malfunctions, and procure replacement parts. Consequently, the cyclotron has experienced frequent breakdowns, leading to prolonged periods of inoperability.

The challenges faced by JNUH are not unique. Among the seven centers established under the regional cyclotron research institute construction project, JNUH is now the only facility still operating its original KIRAMS-13 cyclotron. Other centers have either decommissioned their original cyclotrons in favor of new models from different manufacturers (Pusan National University Hospital, Kyungpook National University Hospital, Jeonbuk National University Hospital, and Seoul National University Bundang Hospi-

Table 1. Year of establishment and current operational status of regional cyclotron centers

Hospital	Year of installation	Current status
Kyungpook National University Hospital	2005	Install new equipment after disposal
Chosun University Hospital	2006	After disposal, it is supplied by other organizations
Pusan National University Hospital	2007	Install new equipment after disposal
Jeonbuk National University Hospital	2008	Install new equipment after disposal
Seoul National University Bundang Hospital	2008	Install new equipment after disposal
Jeju National University Hospital	2009	In operation
Kangwon National University Hospital	2011	After disposal, it is supplied by other organizations

Table 2. Comparison of the current cyclotron center and the new cyclotron center

	Current cyclotron center	New cyclotron center	Increase rate (%)
Daily production of F-18	500 mCi	2,000 mCi or more	300 or more
Number of PET/CT examinations per day	6 cases	12 cases	100
Number of days in operation per year	207 days	238 days	15
Number of PET/CT examinations per year	1,477 cases	2,856 cases	93
Annual revenue	660 million won	1.6 billion won	142
Producible radiopharmaceuticals	FDG FP-CIT	FDG FP-CIT Florbetaben PSMA	100
Use-by dates for equipment	exceeded its use-by date	Semi-permanent	∞

F-18: fluorine-18, PET/CT: positron emission tomography/computed tomography, FDG: fluorodeoxyglucose, FP-CIT: F-18-N-(3-fluoropropyl)-2β-carboxymethoxy-3β-(4-iodophenyl) nortropane, PSMA: prostate-specific membrane antigen.

tal) or have opted to purchase radiopharmaceuticals from nearby suppliers (Chosun University Hospital and Kangwon National University Hospital) (Table 1). These developments underscore the urgent need for a comprehensive solution at JNUH to ensure the continued provision of vital PET/CT imaging services to Jeju Island's residents. To address these challenges, we propose establishing a new, state-of-the-art cyclotron facility at JNUH. The facility will be equipped with an advanced cyclotron from GE HealthCare (Chicago, IL, USA), capable of producing at least 2,000 mCi of F-18 daily, quadrupling the current production capability. The facility will also expand radiopharmaceutical production capabilities, including advanced synthesis units for a broader range of tracers, such as FDG, FP-CIT, F-18 florbetaben for Alzheimer's disease diagnosis, and prostate-specific membrane antigen tracers for advanced prostate cancer imaging. A state-of-the-art quality control laboratory will ensure compliance with the stringent quality and purity standards mandated by Korean regulatory authorities.

The proposal includes a comprehensive staff training program and long-term service and support agreement with GE HealthCare, ensuring the effective operation, maintenance, and sustainability of the new facility. The implementation of this new cyclotron is expected to significantly enhance operational efficiency, increasing annual operating days from 207 to 238 (15% increase) and reducing unplanned downtimes. The daily PET/CT scan capacity is anticipated to double from six to 12 scans, potentially increasing the annual scan volume from 1,477 to 2,856 (93% increase). Additionally, financial performance is expected to improve, with projected annual revenue rising from 660 million to 1.6 billion won (142% increase). Moreover, the expanded diagnostic capabilities, including the addition of Alzheimer's and prostate cancer imaging tracers, will allow JNUH to offer more comprehensive services and open new research opportunities (Table 2). The implementation of this new cyclotron facility represents a pivotal advancement in nuclear medicine and molecular imaging on Jeju Island. It addresses current limitations while positioning the hospital for future growth in patient care, research, and medical technology utilization. This initiative serves as a model for how geographically isolated healthcare settings can maintain and advance their technological capabilities, providing insights for similar efforts worldwide.

ORCID

Ji Young Lee, https://orcid.org/0000-0001-7149-558X
Hee-Sung Song, https://orcid.org/0000-0003-3891-8848

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