Capacity Enhancement of Nuclear Medicine Facilities: Renovation of Institute of Nuclear Medicine and Allied Sciences (INMAS), Rangpur

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ABSTRACT

The increasing demand for diagnostic and therapeutic nuclear medicine services in northern Bangladesh necessitated the capacity enhancement and modernization of the Institute of Nuclear Medicine and Allied Sciences (INMAS), Rangpur. This technical case study presents a comprehensive overview of the renovation project aimed at upgrading infrastructure, improving workflow efficiency, and expanding clinical service capabilities.

The renovation involved strategic redesign of facility layout, installation of advanced imaging equipment, enhancement of radiation safety measures, and optimization of patient management systems. Key interventions included the modernization of gamma camera and SPECT systems, the establishment of dedicated hot labs and radiopharmacy units, and improvements in shielding, ventilation, and waste management systems in compliance with international safety standards.

A systematic methodology involving needs assessment, planning, implementation, and evaluation was adopted for the project, which highlighted human resource development through training for medical physicists and technologists. The upgraded facility allowed for advanced NM procedures and better patient accessibility, alongside improved radiation protection. This case study underscores the significance of integrated planning and regulatory adherence in facility upgrades, positioning INMAS Rangpur as a model for similar initiatives in resource-constrained environments.

Keywords: Nuclear medicine, Renovation, Structural and functional Planning, Diagnostic accuracy.

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INTRODUCTION

During the past decade, Nuclear Medicine (NM) practice has evolved through remarkable advances in radiopharmacy, instrumentation, and information technology, all of which have had prominent roles in propelling its growth. Novel technologies, such as PET, PET/CT, and SPECT/CT, have revitalized the practice of NM; it is expected that other hybrid modalities, such as PET/MRI, and the development of novel radiopharmaceuticals will provide additional impetus for new diagnostic and therapeutic applications, thereby further strengthening the specialty (1, 2). Improved instrumentation with reductions in scanning times and radiation doses administered to patients and improvements in image resolution have enabled more confident and efficient diagnosis while improving a department's workflow (3).

The Institute of Nuclear Medicine and Allied Sciences (INMAS), Rangpur, operating under the Bangladesh Atomic Energy Commission, plays a pivotal role in delivering advanced diagnostic and therapeutic NM services to the northern region of Bangladesh. With a growing population and increasing burden of non-communicable diseases, particularly cancer, thyroid disorders, and cardiovascular conditions, the demand for reliable, timely, and high-quality NM services has significantly increased in recent years.

However, like many healthcare facilities established in earlier decades, INMAS Rangpur faced limitations in infrastructure, equipment capacity, workflow efficiency, and patient handling capabilities. These challenges affected service delivery, constrained the adoption of modern NM technologies, and limited the institute's potential to meet evolving clinical and research demands.

In response, a comprehensive renovation and capacity enhancement initiative was undertaken to modernize the

facility. This included upgrading physical infrastructure, expanding clinical service areas, integrating advanced imaging technologies, improving radiation safety measures, and strengthening human resource capacity. The initiative aligns with national healthcare priorities and global trends in NM, emphasizing precision diagnostics, patient-centered care, and sustainable healthcare delivery.

This technical report discusses the renovation and capacity enhancement of INMAS Rangpur, detailing key interventions, implementation strategies, challenges, and outcomes. It aims to offer insights and best practices for similar initiatives in resource-constrained settings. Major objectives include:

- Enhancing institutional capacity through the installation of modern NM equipments
- Improving infrastructure through construction and renovation of existing buildings.
- Ensuring radiation safety and compliance with international protection standards.
- Developing a functional and user-friendly healthcare environment for patients and staff.

METHODOLOGY

The capacity enhancement and renovation of the Institute of Nuclear Medicine and Allied Sciences (INMAS), Rangpur were carried out through a systematic, multi-phase approach involving (a) baseline technical assessment, (b) planning and design, (c) infrastructure renovation, (d) equipment upgradation and installation, and (e) human resource development.

(a) Baseline technical assessment

A comprehensive evaluation of the facility assessed physical infrastructure, imaging and laboratory equipment status, patient flow and service capacity, and radiation safety compliance. Stakeholder consultations with healthcare professionals identified operational bottlenecks and priority needs

(b) Planning and Design

Architectural redesign was executed to enhance workflow by separating controlled and supervised areas, adhering to radiation protection standards. Modifications and shielding calculations were aligned with IAEA guidelines.

(c) Infrastructure Renovation

Structural strengthening and remodeling of critical areas, like hot lab, radiopharmaceuticals dose preparation and dispensing room and radioactive waste disposal room was done.

(d) Equipment Upgradation and Installation

Replacement and installation of advanced NM imaging systems and modernization of radiopharmacy and radiation monitoring equipment were completed.

(e) Human Resource Development

Hands-on training programs were implemented for physicians, technologists, radiopharmacists, and medical physicists on new equipment and updated safety protocols, including the development of standard operating procedures (SOPs).

OUTCOMES

The old two-and-a-half-storied building structure of INMAS Rangpur, primarily designed for a lower patient volume and with limited equipment occupancy. Due to increasing demand for nuclear medical services and the introduction of advanced diagnostic technologies, renovation became necessary. Given the limited land availability, an additional floor was constructed with the vertical expansion of existing building.

As a part of the strengthening the capability of providing services to a larger quantity of patients, brand new Single Photon Computed Tomography (SPECT-CT), Dual Head Single Photon Computed Tomography (SPECT), Dedicated Thyroid Gamma Camera, Thyroid uptake machine, Bone Mineral Densitometry (BMD), automated radioimmunoassay (RIA) and Chemiluminescence Immunoassay (CLIA) instruments and 4D ultrasound system with color doppler were installed. Space allocation was revised for imaging units, radiopharmacy, Invitro laboratory, post-dose unit, thyroid clinic, patient waiting areas, and waste management systems. Installation of radiation shielding and radiochemistry fume hood in the renovated hot laboratory was performed. Electrical system enhancement with backup power solutions for uninterrupted operation was also done. Radiation protection measures in accordance with national regulations and international standards and quality control (QC) and quality assurance (QA)

protocols were implemented. Calibration and quality assurance testing of all instruments for safe radiotracer preparation and assurance of radiation protection for both the staff and patients was also done. Periodic safety audits and commissioning tests prior to clinical operation were performed.

Figure 1: Modern and upgraded nuclear medicine equipment installed at INMAS Rangpur

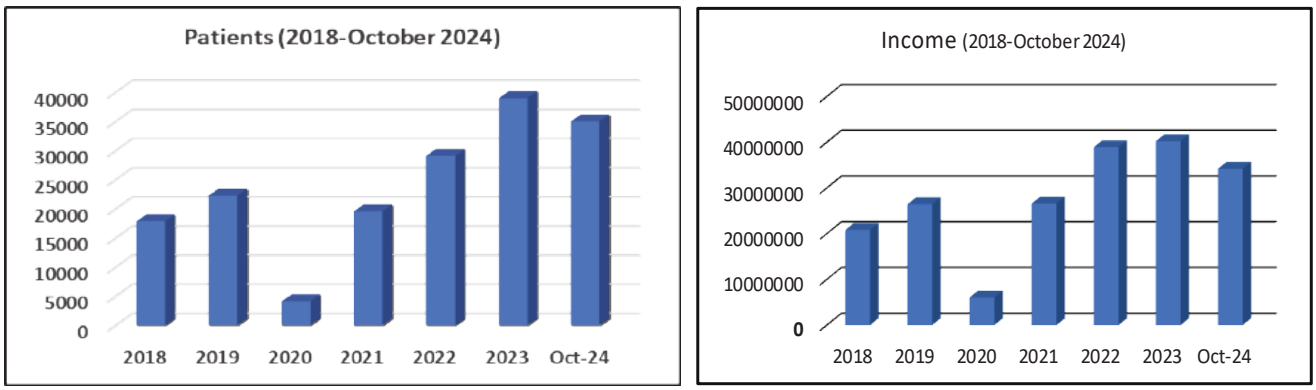

Figure 2: Steady Increment of patients and revenue earning at INMAS Rangpur

With the introduction of hybrid imaging modalities, like SPECT-CT, image quality and diagnostic accuracy for several complex diseases of cardiovascular, neurological, renal, parathyroid and thyroid system including cancer were improved. Upgradation of the unique radio-iodine therapy services for thyroid cancer also ensured safer and more efficient radionuclide therapy delivery to the patients of the region. Upgradation of radiation monitoring, radiation shielding and radiation management system and installation radiochemistry fume hood and dose calibrator in the renovated hot laboratory guaranteed better shielding, contamination control, and waste disposal, which has reduced cross-contamination risk and also improved radiation protection for both the staff and patients. Separate waiting room for post-injection patients with attached toilet facilities have reduced radiation exposure. Expansion of reception and registration areas to improve patient flow and reduce congestion. Installation of a separate breastfeeding corner have provided privacy and comfort for mothers visiting the facility.

DISCUSSION

NM is a vital component of modern healthcare, offering functional imaging and targeted radionuclide therapy for a wide range of diseases, including cancer, thyroid disorders, cardiovascular conditions, and renal diseases.

The first NM facility was built in Dhaka in 1958 in a tin shed called the "Radioisotope Centre," and it was formally opened in 1962 (4). Bangladesh Atomic Energy Commission (BAEC) operates one (01) National Institute of NM and Allied Sciences (NINMAS) and twenty-one (21) Institute of Nuclear Medicine and Allied Sciences (INMAS). There are 21 nationwide INMASes, with four located in Dhaka and the remaining 17 distributed across other locations i.e. Mymensingh, Faridpur, Khulna, Jashore, Satkhira, Kushtia, Pabna, Rajshshai, Rangpur, Dinajpur, Cumilla, Chattogram, Bagura, Gopalganj, Sylhet, Barisal and Cox's Bazar.

INMAS, Rangpur, one of Bangladesh's oldest nuclear medicine institutes, aims to provide specialized medical services through nuclear technology, contributing to socio-economic development. Its renovation showcases effective capacity enhancement in resource-limited conditions, while the incorporation of advanced imaging technologies like SPECT-CT reflects global advancements in molecular imaging and personalized medicine.

The project also highlights the importance of a multidisciplinary approach involving engineers, medical physicists, clinicians, and administrators. The improved infrastructure and workflow significantly enhanced operational efficiency and service quality.

Furthermore, the initiative supports the broader vision of the Bangladesh Atomic Energy Commission to expand NM services across the country, as multiple INMAS centers are undergoing renovation and expansion. However, challenges remain, including sustainable maintenance of advanced equipment, continuous training of personnel, and ensuring uninterrupted supply of radioisotopes.

The recent NEA publication Current Trends in the Supply and Utilisation of Medical Radioisotopes describes challenges and outlines a set of recommendations to guarantee long-term sustainable access to established and new radioisotopes for all stakeholders (5):

- Modernizing infrastructure and diversifying production methods,
- Supporting technological innovations in accelerator-driven and cyclotron-based production,
- Addressing infrastructure gaps, the insufficient numbers of trained health care professionals, and inconsistent regulatory frameworks—especially for novel radioisotopes, and
- Expanding training programs for NM professionals and fostering international collaboration on regulatory alignment.

By addressing these challenges and taking the opportunities, governments can harness the potential of NM and help millions of cancer patients in their countries and around the world.

CONCLUSION

The renovation and capacity enhancement of INMAS Rangpur have improved the quality, accessibility, and efficiency of NM services in northern Bangladesh, serving as a benchmark for similar upgrades nationwide and showcasing the impact of strategic investments in healthcare delivery.

Future efforts should focus on integrating Cyclotron and PET-CT facilities, expanding theranostic applications, and strengthening research collaborations to further advance NM services in Bangladesh.

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