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Radiotheranostics: A Potent Nuclear Medicine Tool for Combating Cancer - Exploring Prospects and Obstacles in Developing Countries

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Theranostics, integrating targeted diagnostic imaging and therapeutic agents, have emerged as an asset of precision oncology (1). Radiotheranostics have revolutionized the field of nuclear medicine (NM) by offering an innovative approach for diagnostic and therapeutic utility (1). This groundbreaking development has equipped radiotheranostic pairs with the ability to precisely target specific pathologies, thereby revolutionizing the management approach of certain cancers, such as prostate cancer and neuroendocrine tumors (2). In the present era, a multitude of radiotheranostics have obtained approval in different corners of the globe. However, numerous others are presently undergoing meticulous examination in clinical trials and preclinical assessments to expand on the use of the radiotheranostic arsenal (2).

Progress in the development of radiotheranostics is noteworthy but not devoid of challenges. These challenges are particularly pronounced in developing nations where more than two-thirds of the population in need is concentrated, leading to significant concerns (3). The implementation of radiotheranostics has faced many challenges associated with the increasing expenses of cancer treatments and the shortage of expertise in many developing countries (4).

Overcoming these financial challenges is crucial for enhancing the feasibility of radiotheranostics and ensuring their availability and accessibility to a broader range of cancer patients. The logistical challenge of many developing countries relying on importing radiopharmaceuticals from distant countries can lead to nonadherence to therapy protocols and the pursuit of alternative approaches. It is crucial to emphasize the noninvasiveness and significance of radiotheranostics in the treatment of diverse cancer types, which has led to their widespread adoption globally. This cannot be achieved without the establishment of a well-equipped team and appropriate facilities to maximize patient efficacy (5).

The reimbursement for radiotheranostics poses a significant financial challenge. The high cost of radiotheranostic agents and equipment, coupled with limited financial resources and infrastructure, hinders its widespread reimbursement. Additionally, the lack of specific reimbursement policies and frameworks for radiotheranostics in developing countries further exacerbates the financial barriers associated with their implementation. These challenges impede the equitable access to radiotheranostic procedures for cancer patients in developing countries, highlighting the need for tailored reimbursement strategies and financial support to ensure the affordability and availability of these innovative agents (6).

To address these challenges and barriers, it is imperative to establish national and international professional cooperation. International professional organizations such as the International Atomic Energy Agency (IAEA), the World Federation of NM and Biology (WFNMB), and the World Association of Radiopharmaceutical and Molecular Therapy (WARMTH), among other international professional societies, are expected to thrust advanced NM training and radiotheranostic practices into developing countries (2).

Recent years have witnessed substantial advancements in radiotheranostics; however, a conspicuous disparity is evident among developing nations. Profound distinctions in the region manifest in varying degrees of human and technical capabilities. Several nations have invested in establishing production facilities for local radioisotope production in nuclear reactors and in-house labeling of radiotheranostics (7). This has led to reduced expenses and increased local supply and availability of radiopharmaceuticals, as well as the establishment of more advanced nuclear medicine centers in the developing world (2). However, this upsurge remains suboptimal in meeting the requisite standards for developing nations as a collective entity. This deficiency is further compounded by a scarcity of skilled radiochemists and radiopharmacists, a challenge that is not confined to developing nations but is also prevalent in developed nations (8). Thus, planning at the national level should take into account both infrastructure and technical capacities, along with manpower and expertise, to meet the expected increase in demands. In this regard, homebrew labeling of radiotheranostics and compassionate use under national and international regulatory authorities may present opportunities in developing nations, as regulatory restrictions are typically less stringent than in the developed world.

Qualifying training programs ending in certificates and licenses to practice centered in NM disciplines is of utmost importance in the coming few years. Although this is needed in most disciplines of NM, some disciplines, like radiopharmacy and radiochemistry, should receive special attention due to their major roles but also their lack of personnel and expertise, which are more prominent in developing nations.

Support is needed to develop radiopharmacists with expertise in regulatory pathways related to investigational new theranostic applications and approvals. Early-stage countries that implemented the theranostic approach and developed the ability to conduct in-house radiolabeling and quality control assurance may establish self-dependency under local regulatory frameworks and international ethical and radiation safety standards. There is also a need to further increase awareness of the usefulness of clinical applications of radiotheranostics. Investing in research nuclear reactors that can produce radioisotopes for use in radiotheranostics shows great potential for developing countries such as Jordan (2). The recognition and implementation of radiotheranostic agents can differ greatly based on the availability of NM imaging methods and regulatory processes. In developing countries, centers that lack adequate resources may face fewer difficulties in meeting regulatory requirements and accreditation due to more lenient regulatory practices. Newly established centers must ensure adequate equipment and staff, be strategically located in densely populated urban areas, and provide adequate reimbursement for both the agent itself and associated medical and technical procedures (9). Failure to establish sufficient reimbursement has resulted in clinically useful drugs potentially failing in the past.

Dosimetry is expected to play a vital role in sustaining and individualizing radiotheranostics, ensuring the precise measurement and calculation of radiation doses for both therapeutic and diagnostic purposes. However, in developing countries, there are significant challenges related to dosimetry. A recent oncology commission report highlighted a serious international shortage of dosimetricians, particularly in developing countries (9). This shortage of trained personnel and equipment hinders the effective implementation of radiotheranostics in these regions. Therefore, addressing the shortage of trained personnel and the availability of necessary equipment is important to overcoming the dosimetry challenges and to opening opportunities for trained staff in developing countries.

To date, many conflict-affected developing nations suffer from compromised access to healthcare facilities, a shift of focus toward military investment, and ongoing security risks. This can impede the delivery of consistent and safe radiotheranostic services. Efforts to advance radiotheranostics should commence incrementally, as waiting for an optimal setup could hinder progress and lead to missed opportunities for growth (4). Vision and determination are essential to initiating small-scale

initiatives, which can gradually expand and evolve. Embracing this approach is crucial for overcoming initial obstacles and preventing disillusionment in the field, ultimately paving the way for sustained advancement in radiotheranostics.

In many developing countries, NM specialists are often perceived by other specialties as diagnostic physicians, which is insufficient due to inadequate infrastructure for training, education, and fellowship programs in theranostic practice. To be eligible for theranostic applications, physicians who have been board-certified must undergo specialized training and accumulate significant practical experience while conforming to the specific curricula of their respective countries (2).

The application and interdisciplinary engagement surrounding radiotheranostics offer numerous opportunities. Successful implementation necessitates collaboration across multiple disciplines, along with ongoing research and education. Close collaboration with medical, surgical, and radiation oncologists is crucial for integrating theranostic agents into cancer patient care. In developing countries, nuclear medicine physicians are expected to spearhead these efforts to demonstrate the value and potential of these innovative tools. However, addressing challenges such as the high costs of agents and equipment, as well as limited resources, requires tailored solutions tailored to each country's specific circumstances. Additionally, the high cost of theranostic agents and equipment, limited research funding, and a lack of training programs can further impede the engagement of multiple specialties in the research and application of radiotheranostics. These challenges underscore the need for concerted efforts to overcome barriers and promote interdisciplinary engagement in radiotheranostics research in developing countries (2).

Advanced countries are implementing licensing programs to facilitate the transition of NM practitioners to theranostic practices, while developing countries such as the Philippines and Jordan are creating fellowship and accreditation programs (2, 10). Such accreditation programs can help establish a solid background for radiotheranostic practice both regionally and internationally.

The promotion of patient awareness and the adoption of advocacy committees can significantly help combat the challenges associated with radiotheranostics. These committees play a crucial role in educating patients, their families, and the general public about the benefits and safety of radiotheranostic procedures, thereby addressing concerns and misconceptions (11). Similarly, real-world and multicenter international research initiatives play a crucial role in promoting the progress of radiotheranostics. Establishing national and international collaborations enables developing countries to actively participate in multi-center clinical real-world research, fostering the exchange of resources, knowledge, and innovations on an international scale. This collaborative approach not only enables the investigation of issues that necessitate larger sample sizes with proper cohort representation from developing nations but also enhances capacity development and mentorship, thereby driving the advancement of radiotheranostics.

To summarize, the complexities associated with implementing theranostics in developing nations are multifactorial. These include financial, logistical, regulatory, and educational factors. By engaging in collective initiatives and fostering international cooperation, these challenges can be efficiently addressed. This, in turn, facilitates the widespread integration of theranostics under the leadership of the nuclear medicine discipline, ultimately improving the prognostic outlook for cancer patients in developing countries.

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