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Narrative Review

The Invisible Backbone of Cancer Care: Empowering Radiation Therapists in Low- and Middle-Income Countries (LMICs) – A Vision for 2040

Subrata Roy [1]*

[1]Senior Radiation Therapist, Department of Radiation Oncology , Nanavati Max Super Speciality Hospital, Mumbai, India.



***Corresponding author:**

Mr. Subrata Roy
Senior Radiation Therapist, Department of Radiation Oncology , Nanavati Max Super Speciality Hospital, Mumbai, India.

Email:
roysubrata217@gmail.com

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ABSTRACT

Background: Radiotherapy is essential to cancer management, yet access remains unequal in low- and middle-income countries (LMICs), where workforce shortages, limited infrastructure and inadequate training constrain service delivery. These gaps further widen disparities between regions and populations globally.

Objective: This article highlights the contribution of radiation therapists (RTTs) and examines priorities for strengthening their professional role towards 2040.

Discussion: It explores workforce challenges, competency-based education, continuing professional development, career progression, research participation and professional recognition. It also considers how artificial intelligence, image-guided radiotherapy and adaptive treatment technologies may reshape clinical practice. Safe implementation requires appropriate training, quality assurance, multidisciplinary collaboration and human oversight.

Conclusion: Empowering RTTs through sustainable education, institutional support, leadership opportunities and policy development is essential to building a skilled workforce and improving access to safe, equitable and high-quality cancer care in LMICs.

Keywords: Radiation Therapists; Radiotherapy; Cancer Care; LMICs; Workforce Development.

INTRODUCTION

Radiotherapy constitutes a critical element of contemporary cancer care, playing a role in cure, disease control, and symptom relief. However, access to radiotherapy remains highly unequal on a global scale. Low- and middle-income countries (LMICs) experience a rising cancer burden in conjunction with shortages of equipment, trained professionals, infrastructure, and educational opportunities. The Lancet Oncology Commission has shown that expanding radiotherapy access can yield significant health and economic benefits, underscoring the need for sustained investment in these services [1]. Subsequent analyses continue to show clear geographical and resource-related disparities [2,3]. Efforts to improve access to radiotherapy commonly emphasize the acquisition of linear accelerators, the execution of advanced treatment-planning systems, and the adoption of sophisticated technologies. While these investments are essential, technology alone cannot ensure safe, accurate, and compassionate care. Successful treatment relies on a skilled multidisciplinary team, comprising radiation oncologists, medical physicists, radiation therapists (RTTs), and oncology nurses. Radiation therapists (RTTs) play a central function in patient preparation, immobilization, image-guided verification, treatment delivery, radiation safety, and patient support. Despite this, professional recognition, educational opportunities, career advancement, and involvement in research and leadership remain inconsistent. Looking toward 2040, empowering RTTs should be a core part of strategies to establish equitable, sustainable, high-quality cancer care.

THE WORKFORCE CHALLENGE: A GLOBAL CONCERN: Installing treatment machines alone is not enough to increase radiotherapy capacity; you also need a workforce properly trained and able of use the machines safely and effectively. An international survey of radiation therapy training and education, which included responses from 90 countries, found significant deficiencies in radiation therapy-specific education and clinical training [4]. The 2024 Lancet Oncology Commission on radiotherapy and theranostics likewise pointed out that the availability of a properly trained and credentialed workforce is a major barrier to the effective implementation of radiotherapy, especially in low- and middle-income countries [5]. The results indicate that efforts to develop the workforce should go beyond simply increasing the number of professionals joining the field; they should include structured education, supervised clinical

training, assessment of competency, continuing professional development (CPD), and well-defined career pathways. The low- and middle-income countries do not form a single, uniform group. A number of them have set up radiation therapy programmes based in universities and possess more advanced radiotherapy centres, while others have limited capacity for training and uneven access depending on location. Within the same country, differences can exist between large urban areas and less well-served regions in professional opportunities and available resources. If these inequalities are not tackled, countries will need to carry out national workforce planning, invest in local education, and introduce policies that promote recruitment and retention. Without such measures, the expansion of technology could go ahead faster than the number of professionals available to give treatments safely.

FROM TREATMENT OPERATORS TO CLINICAL LEADERS: The role of the RTT extends significantly beyond the operation of treatment equipment. Routine practice demands comprehensive anatomical knowledge, technical precision, clinical judgement, effective communication skills, and the capacity to identify discrepancies that could compromise treatment accuracy. Advancements such as image-guided radiotherapy, stereotactic treatments, adaptive radiotherapy, and artificial intelligence (AI) are generating new opportunities for professional development. These innovations necessitate structured education, critical thinking, validation of technology-assisted outputs, and rigorous quality assurance [5,6]. In low- and middle-income countries (LMICs), this progression offers the potential to establish career pathways that acknowledge advanced competencies and promote increased involvement in clinical improvement. Subject to national regulations and demonstrated competence, RTTs may contribute to image-guided workflows, protocol development, patient education, quality improvement, and research. However, expanding responsibilities without adequate training, supervision, recognition, and accountability poses significant risks. Competency, underpinned by competency frameworks, clearly defined scopes of practice, and multidisciplinary collaboration, must support role development. RTTs ought to be acknowledged as clinical professionals whose expertise is integral to treatment quality and patient safety. Their participation in departmental decision-making and service development should be informed by their practical knowledge of treatment delivery and the patient experience.

EDUCATION: BUILDING SUSTAINABLE LOCAL EXPERTISE: Education forms the bedrock of a resilient RTT workforce. From the outset, training should integrate radiation physics, radiobiology, anatomy, treatment techniques, radiation protection, patient care, and hands-on clinical experience. Equally vital is ensuring ongoing access to lifelong learning so professionals can keep pace as technologies and clinical expectations shift. The IAEA's handbook for RTT education serves as a valuable springboard for building robust, structured educational programmes [7]. Universities, hospitals and professional societies should join forces to craft curricula that reflect national needs while embracing international standards. Regional training hubs can become vibrant centres for clinical placements, practical workshops and mentorship, especially for professionals in resource-limited settings. Virtual learning platforms open doors to webinars, case discussions and expert-led teaching, extending opportunities far beyond traditional classrooms. While digital education cannot fully replace hands-on experience, it can bridge distances and support ongoing professional growth. International mentorship should champion knowledge sharing and nurture local leadership. Those trained through collaborative programmes deserve pathways to become educators, mentors and researchers within their own healthcare systems. The goal extends beyond increasing RTT numbers; it is about cultivating a workforce ready to embrace clinical innovation, uphold excellence and elevate local practice.

SAFE RADIOTHERAPY WITHIN RESOURCE CONSTRAINTS: In resource-limited settings, radiotherapy teams may face high patient volumes, staffing shortages, equipment downtime and financial pressures. These challenges make standardized workflows, effective communication, and robust quality systems particularly important. Research on radiotherapy capacity in LMICs has described substantial gaps in infrastructure and service availability [8]. The IAEA's QUATRO audit experience also demonstrates the value of systematic assessment and recommendations for improving radiation oncology services [9]. RTTs can support service resilience through accurate patient identification, reproducible positioning, appropriate immobilization, adherence to approved imaging protocols, precise documentation, and timely escalation of discrepancies. Standard operating procedures can promote consistency in patient preparation, image acquisition, setup verification, correction application and treatment documentation. Competency assessments, incident reporting and multidisciplinary reviews can

identify recurring problems and support continuous improvement. However, resource constraints must never become a justification for compromising essential safety standards. New techniques require appropriate training, commissioning, quality assurance and clinical governance. Recent work on structural quality indicators in radiation oncology identifies workload, infrastructure, machine downtime, adequacy of training and access to services as important elements of service quality [10]. Staff well-being matters just as much: excessive workloads, fatigue, and inadequate staffing can threaten treatment quality and retention.

ARTIFICIAL INTELLIGENCE: PROGRESS WITHOUT INEQUALITY: AI may improve efficiency by outlining treatment areas, matching images, verifying treatments, and optimizing workflows. For LMICs, these developments could help them use limited resources more effectively, as long as their use is medically justified and sustainable. However, the possible benefits depend on local testing, data management, infrastructure, cost, and staff training. Before adopting new systems, institutions should check if they fit medical needs, how much upkeep costs, if they work with current equipment, and how well they perform for their patients. RTTs must know what AI tools can and cannot do, spot unreliable results, and report problems properly. Human supervision and clear professional responsibility must stay central to using these tools. A 2026 systematic review of AI deployments in low-resourced radiation oncology examines implementation and scale-up challenges, underlining the importance of readiness and responsible integration [11]. By 2040, AI may be embedded in many routine radiotherapy workflows. The key question is whether all healthcare systems will have the resources and trained professionals to benefit. Technology should enhance professional judgment, not diminish the value of human expertise.

RESEARCH, RECOGNITION AND INTERNATIONAL COLLABORATION: A sustainable RTT profession requires opportunities to contribute to research, education, leadership, and policy development. Yet heavy clinical workloads and limited institutional support may leave little time for these activities. RTT-led research can address locally relevant questions concerning treatment accuracy, workflow efficiency, patient experience, quality assurance, and workforce development. Institutions should support mentorship, protected research time,

collaborative projects and opportunities to publish findings. Professional societies can strengthen these efforts through research networks, educational resources, conference participation, and small-grant programs. RTT representation in departmental committees, professional associations and national cancer-care discussions should also be encouraged. International collaboration can accelerate progress through shared education, virtual mentorship, research partnerships and specialist exchanges. The IAEA has supported the development of radiotherapy infrastructure, workforce training and safe radiation medicine services in LMICs [12]. Partnerships should strengthen local capacity rather than create long-term dependence on external expertise. Local professionals should help define priorities, lead implementation and evaluate outcomes. International standards provide valuable guidance, but their implementation must reflect national regulations, resources, and patient needs.

LOOKING TOWARDS 2040: A VISION FOR THE RTT PROFESSION: By 2040, the aim must be that every radiotherapy treatment technician, no matter where they are from or the resources available to their institution, should have access to suitable education, professional recognition and development opportunities. Education through RTT in the future will be based on developing competencies, closely linked internationally and tailored to meet local healthcare needs. Access to continuing education will be improved by the use of digital learning and by regional mentorship networks, and approved career routes will aid progression into clinical practice, education, research, management and leadership. Radiotherapy professionals will need to be able to critically assess technology, ensure patient safety and keep the human element at the heart of cancer care in the case of AI-assisted and adaptive radiotherapy. Within the scope of their practice, RTTs will take a more active role in quality improvement, service design and multidisciplinary decision-making. Action must now be taken to achieve this vision. Governments ought to include RTT workforce planning in their national cancer-control strategies. Institutions should invest in training, hiring, and retaining staff. Educational providers should improve clinical learning, and professional societies should encourage research, leadership and international collaboration. Assess progress using measurable indicators such as educational capacity, the level of competency levels, workforce retention, CPD participation, research activity, and improvements in service quality of services. The vision for 2040 needs to become a practical program of action, not remain an aspirational statement.

CONCLUSION

The future of equitable radiotherapy rests not just on cutting-edge machines, digital breakthroughs or expanded treatment capacity, but on the expertise, insight and growth of those who deliver care. RTTs are the backbone of safe, precise and compassionate cancer care. Their vital role deserves support through robust education, stable staffing, inspiring career paths, research opportunities and a seat at the leadership table. In LMICs, empowering RTTs is not just a workforce measure; it is a bold investment in the quality, resilience and fairness of cancer services. By 2040, true success will go beyond delivering advanced radiotherapy technology to more countries. It will mean that every radiotherapy service is powered by a skilled, supported and empowered workforce ready to use that technology safely and effectively. The moment to shape that future begins today.

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