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COMMENT

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Availability of radiation therapy facilities in Iran in a global context

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Despite the latest advances, the global disparity in access to radiation therapy is still a concern, particularly in resource-limited countries such as Iran. This comment aims to raise awareness about the lack of radiotherapy facilities in Iran and advocate for infrastructural improvement to ensure adequate response to increasing cancer cases.

Background

Radiation therapy (RT) is an essential pillar of modern cancer management, with over half of cancer patients requiring RT during their course of treatment [1]. It has demonstrated efficacy for a broad spectrum of malignancies, with innovations such as intensity-modulated radiation therapy (IMRT), volumetric modulated arc therapy (VMAT), stereotactic body radiation therapy (SBRT), and image-guided radiation therapy (IGRT) improving treatment outcomes through enhanced precision and reduced toxicity. The availability of advanced RT centers is not only a convenience but an ethical imperative to ensure equitable cancer care. Despite the latest technological advances in RT, the global disparity in access to RT is still a concern, particularly in resource-limited countries like Iran.

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The availability and quality of RT services determine the outcomes of cancer treatment. Recent studies have investigated the status and availability of RT facilities and their predicted demand for the upcoming decades. Global accessibility is far from its ideal, particularly in low- and middle-income countries (LMICs), and over two-thirds of the cancer cases are expected in these countries in the upcoming decades, without sufficient capacity to address the additional burden [1].

Here, we discuss the current state of RT facilities in Iran, compare it with global benchmarks, and draw the need for improvements to bridge the existing infrastructural gaps.

Status and recent trends in Iran

Over the past decade, Iran has made significant progress in expanding its RT infrastructure, raising the amount of equipment per million population (EPMP) from around 0.5 to 1.5 [2]. The latest report from the IAEA Directory of Radiotherapy Centers (DIRAC) locates 81 RT centers in Iran, with an overall of 123 megavoltage (MV) and 16 brachytherapy units [3]. The Global Health Observatory and DIRAC have reported an EPMP of 1.53 (2023) and 1.63 (2021) in Iran, respectively. Currently, with an EPMP of 1.52, Iran stays behind the international recommendations for the ideal of four RT machines per million population to answer the rising demand for cancer treatment and align with the global benchmark [4].

Besides the numerical inadequacy, care disparities are exacerbated by the uneven geographical distribution of RT centers in Iran. Tehran, the capital of Iran, maintains over one-third of all available equipment. The urban-centric distribution leaves patients in underserved rural areas with limited access, forcing many to travel long distances

for treatment, leading to substantial financial toxicity (the economic burden of medical expenses, travel, and indirect costs such as lost income) and time toxicity (the excessive time burden required for planning and accessing care, including travel, waiting, and treatment duration) [5]. Such barriers often lead to delayed treatment, adversely affecting patient outcomes. The quality and age of RT equipment also play a major role in treatment efficacy, since aging compromises equipment precision and increases the likelihood of technical failures and downtime. In fact, the need for new and updated equipment has the highest priority for improvement in all LMICs [6]. Iran has phased out most cobalt-60 machines—the simpler and cost-effective high-energy gamma-producing RT devices—in favor of linear accelerators—more advanced, precise, and versatile RT devices, generating high-energy x-rays or electrons, with the capability of delivering complex treatment plans. However, the average age of the RT machines remains a concern [2]. Moreover, advanced modalities like proton therapy and heavy-ion therapy, which are becoming part of standard treatment protocols in high-income countries, are virtually non-existent in Iran. Notably, less than 40 radiation oncologists have been annually trained through residency programs since 2017, which are limited to major universities and hospitals in the country. Moreover, around 25% and 40% shortages of medical physicists and radiotherapy technologists in Iran are reported, respectively [2].

Global context

Overall, the global average of EPMP is currently 2.52, with European countries leading with an average EPMP of 7.36. High-income countries have established robust RT infrastructures, often exceeding the discussed minimum recommendations. For instance, the EPMP for France, the Netherlands, and the USA is more than 10, complemented by the latest technologies and highly trained personnel [3]. Moreover, access to RT facilities is significantly superior, whereas in the USA, for instance, over three out of every four people live within the 12.5-mile radius of an RT facility [7].

Türkiye, a country with a population size similar to Iran, has made significant improvements in expanding its RT infrastructure. Türkiye operates 144 RT centers equipped with 298 MV and 31 brachytherapy units, resulting in an EPMP of over 3.75 [3]. Meanwhile, Egypt, with a population of around 115 million, faces similar challenges in meeting its RT needs with an EPMP of 1.27. Their workforce is also insufficient to meet the growing demand for cancer treatment services, in response to which the specialty training capacity for radiation oncologists has been increased in recent years [8]. Mexico, Thailand, and Brazil with similar socioeconomic and population characteristics have higher EPMPs than Iran (2.1, 2.26, and 2.4, respectively), with Thailand even benefiting from light ion therapy facilities [3]. Moreover, data show significant improvement in access to RT facilities in the mentioned countries, as, for instance, the number of inhabitants per external beam RT device has decreased from around 865,000 to around 628,000 for Mexico and from around 778,000 to 565,000 for Brazil in the last 5 years [3, 9].

Health impacts of limited RT facilities in Iran

The shortfall of RT equipment per international recommendations will ultimately result in unfavorable health outcomes, including delayed treatment, increased mortality rates, financial toxicity, and profound geographical disparities in health outcomes and survival rates. A recent meta-analysis has estimated a 9% increased mortality for a 4-week delay in RT of head and neck cancer patients [10]. An estimated 11.4 million life-years could be saved through a two-decade scale-up of RT in LMICs, just from cervical cancer [11]. Delayed or inadequate treatment also results in disease progression, necessitating more intensive and costly interventions. This not only strains healthcare resources but also imposes significant financial hardships on patients and their families. Profound psychological distress for patients and their families may also result, as waiting for treatment can lead to uncertainty, anxiety, and a diminished sense of control over the disease. Consequently, the lack of adequate RT infrastructure not only contributes to a higher burden of disease but may also inadvertently contribute to worsening socioeconomic inequalities, as the most vulnerable populations—those with limited access to urban centers—are disproportionately affected.

Conclusions

Cancer is a growing public health concern worldwide, specifically in resource-limited countries, including Iran. Delayed or inadequate treatment not only compromises survival rates but also places a massive burden on patients and the healthcare system. Investing in RT infrastructure is, therefore, not merely a matter of improving cancer survivorship but also an essential step toward socioeconomic stability. The urgency of action is further emphasized through the increasing prevalence of cancers requiring RT. For instance, breast cancer, the most common malignancy among Iranian women, often requires a combination of surgery and RT for optimal management. Failure to address these technical gaps will likely result in a growing backlog of untreated cases, undermining the progress made in cancer care over the years.

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MSH: Conceptualization, data review, writing. The author read and approved the final manuscript.

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