

2025年湖南省放射治疗资源配置与服务能力调查

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[摘要] 目的: 放射治疗(以下简称“放疗”)作为治疗恶性肿瘤的重要手段, 60%~70%的恶性肿瘤患者需要进行此类治疗。本研究旨在通过对湖南省2025年放疗的现状进行深入调查与分析, 为优化全省放疗资源布局、提升肿瘤诊疗服务能力及完善区域放疗体系提供依据。方法: 根据湖南省肿瘤诊疗医疗质量控制中心统一制订的放疗基本情况调查表, 采用线上填报与线下复核相结合的方式, 对湖南省开展放疗的医疗机构进行调查。调查内容包括放疗机构基本信息、人员配置、放疗设备及辅助设备配置、放疗技术开展情况、患者收治数量及质量控制体系建设等。调查时间为2025年7月至9月, 由各市州肿瘤诊疗质量控制中心统一组织实施。所有数据经整理核查后, 由湖南省肿瘤诊疗质量控制中心通过抽样实地检查进行真实性验证。结果: 截至2025年9月, 湖南省共有放疗医疗机构90家, 较2022年增加14家, 其中三级医院70家(77.78%), 公立医院74家(82.22%), 仍为主要服务主体。非省会医院年度放疗患者占比由26.5%上升至29.3%。全省放疗从业人员2 057人, 包括临床医师889人、物理师231人、技师433人、护师444人及工程师60人, 医师与物理师比例为3.8:1。设备配置方面, 全省共有外照射设备127台, 其中医用加速器115台[含螺旋断层放疗系统TOMO(Tomotherapy)4台]、伽马刀12台; 内照射后装治疗机33台。辅助设备包括模拟定位机85台、治疗计划系统210套、剂量仪199台及验证设备114套。与2022年相比, 直线加速器数量增长30.59%, CT模拟定位机数量增长61.54%, 剂量验证设备数量增长93.22%。全省每百万人口加速器拥有量达到1.73台, 但区域间资源分布仍存在差异。国产加速器占比由2022年的10.22%提升至14.41%。在放疗技术开展方面, 全省已形成以调强放疗(intensity modulated radiation therapy, IMRT)为核心的精准放疗体系, IMRT开展率达84.4%; 图像引导放疗(image guided radiation therapy, IGRT)、立体定向放疗(stereotactic body radiotherapy, SBRT)及呼吸运动管理技术覆盖约45%的放疗机构。在患者收治方面, 全省放疗单位年度累计收治患者总数约为48 000人。主要病种为肺癌、乳腺癌、宫颈癌、鼻咽癌及直肠癌, 占比60.11%。随着《湘医保发〔2025〕18号》实施, IMRT、容积旋转调强放疗(volumetric modulated arc therapy, VMAT)、TOMO及SBRT等精准放疗技术已纳入医保乙类支付范围, 显著提升了精准放疗技术的可及性与可负担性。结论: 2025年湖南省放疗服务能力较2022年明显提升, 表现为放疗机构与设备数量增加、精准放疗技术普及及质量控制体系完善, 已基本形成以IMRT为核心的现代精准放疗体系。医保支付政策优化进一步提升了高精度放疗技术的可及性。与此同时, 区域资源配置不均、基层设备利用效率不高及高层次医学物理人才储备不足等问题仍然存在。未来需进一步优化区域协同与资源布局, 提升基层放疗能力及质量控制同质化水平, 促进放疗服务体系均衡发展。

[关键词] 放射治疗; 资源配置; 放射治疗单位; 调查研究; 湖南省

收稿日期(Date of reception): 2025-11-24

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基金项目(Foundation item): 湖南省自然科学基金科卫联合基金(2026JJ81742); 湖南省卫生健康委卫生适宜技术推广项目(202319015975); 湖南省肿瘤医院高层次人才五年行动计划支持(20250731-1009; 20250731-1016)。This work was supported by the Hunan Provincial Natural Science Foundation and Health Joint Fund (2026JJ81742), the Hunan Provincial Health Commission Health Appropriate Technology Promotion Project (202319015975), the High-Level Talent Support Program of Hunan Cancer Hospital (20250731-1009; 20250731-1016), China.

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Survey of radiotherapy resource allocation and service capacity in Hunan Province, 2025

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ABSTRACT

Objective: Radiotherapy is one of the most important treatment modalities for malignant tumors, with 60% to 70% of cancer patients requiring radiotherapy during the course of their disease. This study aims to comprehensively investigate and analyze the current status of radiotherapy in Hunan Province in 2025, providing evidence for optimizing the allocation of radiotherapy resources, enhancing oncology service capacity, and improving the regional radiotherapy system across the province.

Methods: Based on the standardized radiation therapy basic information survey form developed by the Hunan Provincial Medical Quality Control Center for Cancer Diagnosis and Treatment, a combined approach of online data submission and offline verification was used to conduct a survey among medical institutions in Hunan Province providing radiation therapy services. Data were collected through a combination of online reporting and on-site verification. Survey items included institutional characteristics, workforce allocation, radiotherapy equipment and auxiliary facilities, implementation of radiotherapy technologies, patient volume, and quality control system development. The survey was conducted from July to September 2025 under the coordination of municipal cancer diagnosis and treatment quality control centers. After data collation and verification, the authenticity of the reported information was further validated through random on-site inspections conducted by the Hunan Provincial Quality Control Center for Cancer Diagnosis and Treatment.

Results: As of September 2025, Hunan Province had 90 radiotherapy institutions, representing an increase of 14 institutions compared with 2022. Among them, 70 (77.78%) were tertiary hospitals and 74 (82.22%) were public hospitals, which remained the major service providers of radiotherapy services. The proportion of annual radiotherapy patients treated in non-capital-city hospitals increased from 26.5% to 29.3%. A total of 2 057 radiotherapy professionals were employed province-wide, including 889 physicians, 231 medical physicists, 433 radiation therapists, 444 nurses, and 60 engineers, yielding a physician-to-physicist ratio of 3.8:1. In terms of equipment, there were 127 external beam radiotherapy units, including 115 medical accelerators (of which 4 were Tomotherapy [TOMO] systems) and 12 Gamma Knife units, as well as 33 brachytherapy afterloading systems. Auxiliary equipment included 85 simulation units, 210 treatment planning systems, 199 dosimeters, and 114 verification systems. Compared with 2022, the numbers

of linear accelerators, CT simulators, and dose verification devices increased by 30.59%, 61.54%, and 93.22%, respectively. The province achieved 1.73 linear accelerators per million population, although regional disparities in resource distribution persisted. The proportion of domestically manufactured linear accelerators increased from 10.22% in 2022 to 14.41% in 2025. Regarding radiotherapy technologies, a precision radiotherapy system centered on intensity-modulated radiation therapy (IMRT) had been established, with an IMRT implementation rate of 84.4%. Approximately 45% of radiotherapy institutions had adopted image-guided radiation therapy (IGRT), stereotactic body radiotherapy (SBRT), and respiratory motion management technologies. The annual number of patients receiving radiotherapy across the province reached approximately 48 000. The most common cancer types treated were lung cancer, breast cancer, cervical cancer, nasopharyngeal carcinoma, and rectal cancer, accounting for 60.11% of all radiotherapy cases. Following the implementation of Hunan Medical Insurance Policy [2025] No. 18, precision radiotherapy techniques, including IMRT, volumetric modulated arc therapy (VMAT), TOMO, and SBRT, were incorporated into the Category B reimbursement list of the provincial medical insurance program, substantially improving their accessibility and affordability.

Conclusion: The radiotherapy service capacity of Hunan Province improved substantially in 2025 compared with 2022, as evidenced by increases in the number of radiotherapy institutions and equipment, wider adoption of precision radiotherapy technologies, and further enhancement of quality control systems. A modern precision radiotherapy framework centered on IMRT has been largely established. Optimization of medical insurance reimbursement policies has further improved access to advanced radiotherapy technologies. Nevertheless, challenges remain, including unequal regional distribution of radiotherapy resources, suboptimal utilization efficiency of equipment in primary-level institutions, and shortages of highly qualified medical physicists. Future efforts should focus on strengthening regional coordination and resource allocation, enhancing radiotherapy capacity at the primary care level, improving the standardization of quality control practices, and promoting balanced development of the radiotherapy service system.

KEY WORDS radiotherapy; resource allocation; radiotherapy institution; survey research; Hunan Province

随着中国恶性肿瘤发病率的逐年攀升, 癌症已成为严重威胁人民健康的重大公共卫生问题^[1-3]。放射治疗(以下简称“放疗”)作为治疗恶性肿瘤的重要手段, 60%~70%的恶性肿瘤患者需要进行此类治疗^[4-7]。湖南省作为中部地区的经济强省, 近年来在放疗学科方面稳步发展。本研究旨在通过对湖南省2025年放疗的现状进行深入调查与分析, 为优化全省放疗资源布局、提升肿瘤诊疗服务能力及完善区域放疗体系提供依据。

1 对象与方法

1.1 对象

本研究采用历史对照设计, 调查对象涵盖当前组与历史对照组。当前组数据来源于2025年湖南省开展放疗的所有医疗机构的实地调查; 历史对照组数据则引自本课题组前期发表的文献[8], 选取其中2022年相关数据作为基准。调研范围覆盖湖南省下辖的13个地级市及1个自治州(长沙市、株洲市、湘潭市、衡阳市、郴州市、永州市、怀化市、张家界

市、常德市、岳阳市、娄底市、邵阳市、益阳市、湘西土家族苗族自治州)。调查内容包括放疗单位基本信息、人员配置、放疗设备(治疗、辅助、质控)配置、技术开展、患者收治人数等情况。放疗收费标准参考《湘医保发〔2025〕18号》文件^[9]。

1.2 方法

根据湖南省放疗质量控制中心调查内容设计统一的放疗基本情况调查表,由各市州肿瘤诊疗质控中心发放调查问卷,指定各医院肿瘤科或放疗科负责人填写,同时各医院放射防护专员对填报工作进行督导。表格自2025年7月10日分发,截至2025年9月30日全部回收,由本项目研究小组进行数据整理和核查。2025年9月至10月,湖南省肿瘤诊疗质量控制中心采用抽样调查的方式,对相关放疗机构进行放疗质控工作实地检查,并核对调查问卷填报情况。

1.3 统计学处理

以放射诊疗机构名称和统一社会信用代码为被

调查单位唯一依据,利用Excel软件建立数据库并进行数据录入与整理,重点对数据进行逻辑性和正确性查验。采用Origin 2021软件进行统计分析及绘图。定性资料以频数(%)表示,采用 χ^2 检验进行分析。检验水准 $\alpha=0.05$, $P<0.05$ 为差异有统计学意义。

2 结果

2.1 放疗单位情况

2025年度,湖南省开展放疗的医疗机构总数为90家。从医院等级分布看,三级医院70家(77.78%),二级医院20家(22.22%;图1A)。从机构性质看,公立医院74家(82.22%),民营医院16家(17.78%;图1B)。在行政隶属方面,地方医院(非部队医院)88家(97.78%),部队医院2家(2.22%)。与2022年相比,湖南省放疗单位的数量从76家增加至90家,增长14家。在患者收治结构上,非省会医院(市县级医院)的年度收治量占比由2022年的26.5%上升至2025年的29.3%。

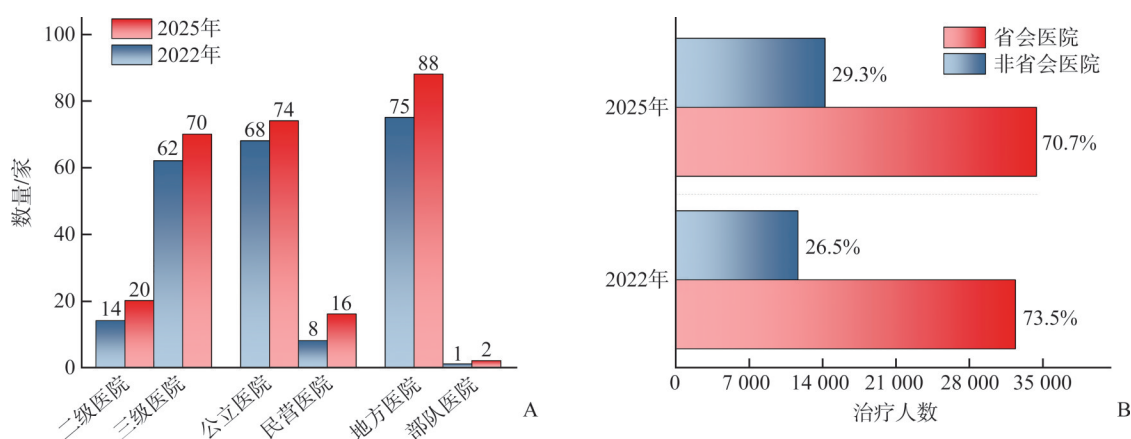


图1 湖南省放疗资源布局与治疗规模概况

Figure 1 Overview of radiotherapy resource layout and treatment scale in Hunan Province

A: Distribution of radiotherapy facilities in Hunan Province. B: Statistics of the top 10 hospitals by annual number of treated patients in Hunan Province.

2.2 放疗从业人员情况

截至2025年,湖南省从事放疗的工作人员总数为2 057人。在人员构成方面,全省的临床医师、物理师、技师、护师和工程师的数量分别为889人、231人、433人、444人和60人,医师与物理师的比

例约为3.8:1(图2A)。在职称结构方面,放疗临床医师以高级和中级职称为主;在物理师中,中级及以上职称占比为73.16%;而在技师群体中,初级职称占比达50.58%(图2B)。

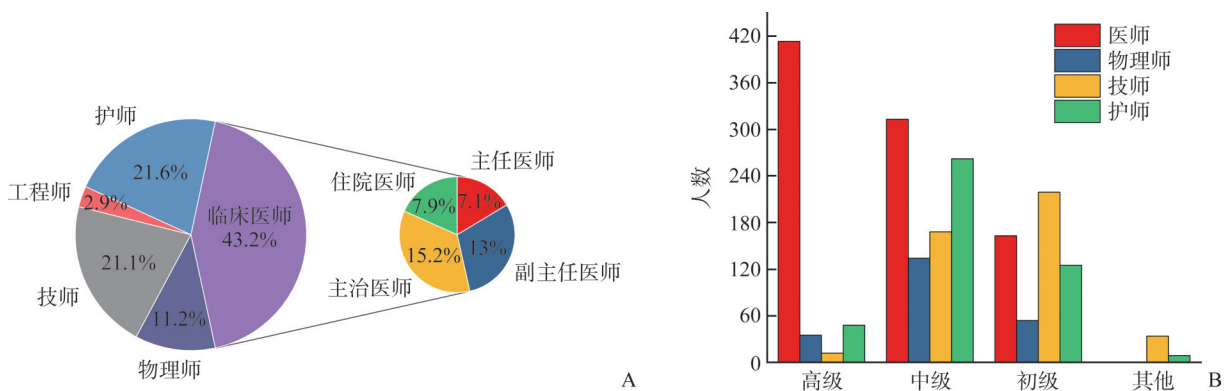


图2 湖南省放疗工作人员岗位与职称构成分析

Figure 2 Composition analysis of radiotherapy staff by position and professional title in Hunan Province

A: Distribution of radiotherapy staff by position. B: Distribution of radiotherapy staff by professional title.

2.3 放疗设备分布和利用情况

湖南省放疗基本设备配置情况的调查结果(图3)显示,省内医疗机构已普遍配备直线加速器、后装治疗机、模拟定位机(含常规模拟机及CT模拟机)、三维治疗计划系统(three-dimensional radiation therapy planning system, TPS)及剂量验证设备。在医院等级分布上,部分三级医院存在后装治疗机配置缺失的问题。截至2025年9月,全省外照射放疗设备总计127台,其中医用加速器共115台[含螺旋断层放疗系统TOMO(Tomotherapy)4台],伽马刀12台;内照射设备(后装机)33台。配套设施中,模拟定位机85台,TPS 210套,剂量仪199台,三维水箱22台,验证设备114套。此外,人工智能靶区勾画系统配置量达到17套。与2022年数据对比,2025年全省放疗设备总量呈增长态势(图3)。直线加速器由85台增至111台(增幅30.59%),后装机由28台增至33台(增幅17.86%),模拟定位机由68台增至85台(增幅25.00%)。在模拟定位机内部构成中,CT模拟机由39台增至63台(增幅61.54%),而MR模拟定位机维持在3台。质控设备数量增幅显著,其中剂量仪和验证设备分别增长113.98%和93.22%。

全省各市(州)放疗设备分布结果(表1、图4A)显示,长沙市拥有放疗单位18家,加速器29台,每百万人口加速器拥有量为2.89台;常德市和岳阳市的加速器配置分别为12台(2.27台/百万人)和10台(1.98台/百万人),均高于全省平均水平(1.73台/百万人);相比之下,娄底市(1.04台/百万人)、邵阳市(1.07台/百万人)及湘潭市(1.10台/百万人)的每百万人

口加速器拥有量处于全省较低水平。在设备品牌分布方面,全省111台直线加速器中,进口品牌95台(85.59%),国产品牌16台(14.41%;图4B)。与2022年数据相比,国产品牌占比由10.22%变为14.41%。

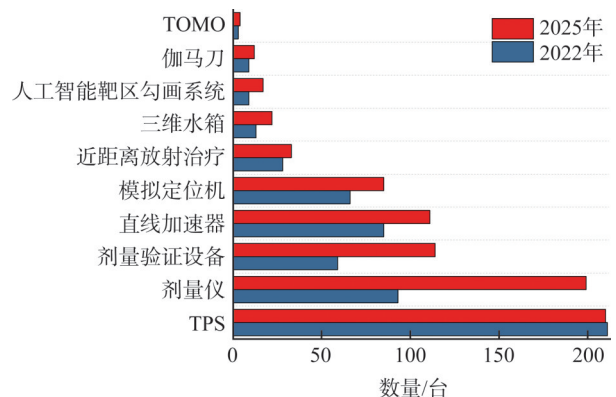


图3 2025年湖南省放疗设备情况

Figure 3 Overview of radiotherapy equipment in Hunan Province on 2025

TOMO: Tomotherapy; TPS: Three-dimensional radiation therapy planning system.

设备利用率及不同等级医院分布结果(图5A)显示,全省加速器平均年治疗人数(n)分布如下: $n \leq 300$ 的单位39家, $300 < n \leq 600$ 的单位20家, $600 < n \leq 900$ 的单位10家, $n > 900$ 的单位15家;与2022年相比, $n > 900$ 的单位由7家增至15家,同时 $n \leq 300$ 的单位由33家增至39家。在后装机利用方面(图5B), $n \leq 100$ 的单位19家, $n > 600$ 的单位3家。

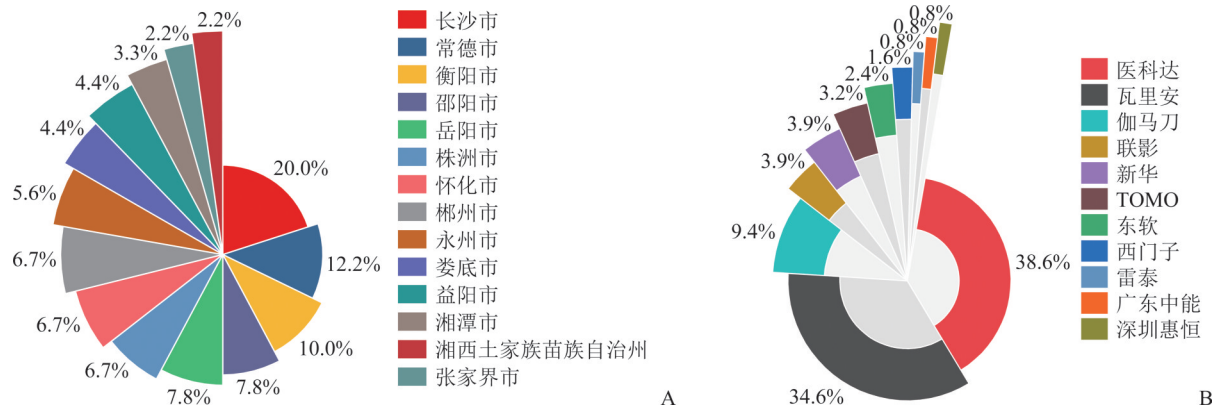


图4 湖南省医用加速器资源配置水平与品牌分布

Figure 4 Medical linear accelerator resource allocation and brand distribution in Hunan Province

A: Geographic distribution of medical linear accelerators per million population in Hunan Province. B: Market distribution of medical linear accelerator brands in Hunan Province. TOMO: Tomotherapy.

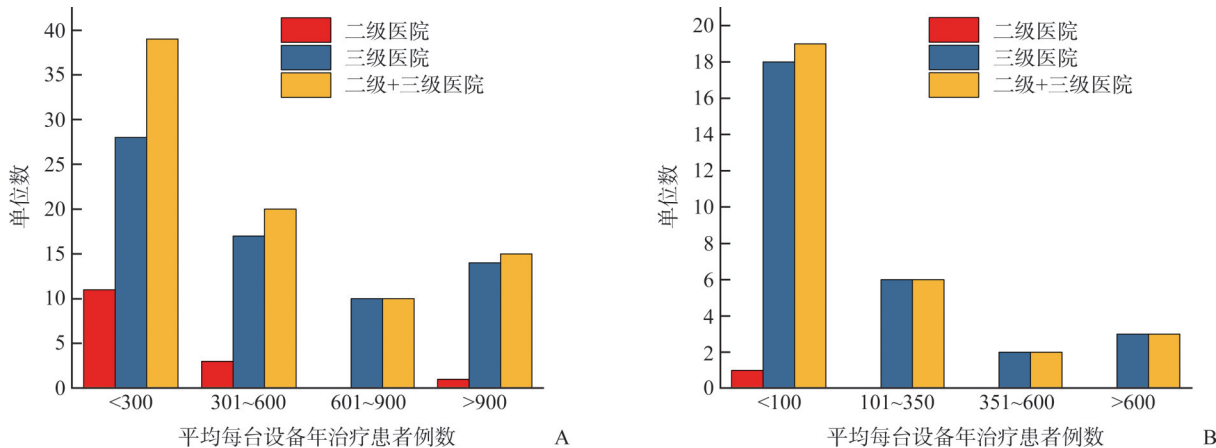


图5 湖南省不同等级医院放疗设备利用效率分析

Figure 5 Analysis of radiotherapy equipment utilization efficiency in hospitals of different levels in Hunan Province.

A: Utilization of medical linear accelerators (n represents the average annual number of patients treated per device). B: Utilization of brachytherapy afterloaders (n represents the average annual number of patients treated per device).

2.4 放疗技术开展与患者收治情况

湖南省医疗机构放疗技术开展情况(图6A)显示,在外照射技术中,2025年开展调强放疗(intensity modulated radiation therapy, IMRT)的单位共76家,图像引导放疗(image guided radiation therapy, IGRT)42家,立体定向放疗(stereotactic body radiotherapy, SBRT)41家,呼吸运动管理技术41家。开展容积旋转调强治疗(volumetric modulated arc therapy, VMAT)为34家,还有30家单位在开展三维适形放疗(three-dimensional conformal radiotherapy, 3D-CRT)。在近距离治疗领域,30家单位开展后装放疗。截至2025年10月,全省90家放疗单位年度累计收治患者总数

约为48 000人。不同放疗技术的临床应用人次分布结果(图6B),其中IMRT和VMAT的应用人次位居前列。

2.5 主要病种分布及放疗费用情况

调查数据显示,湖南省2025年放疗收治排名前5的病种及其占比(图7A)分别为:肺癌(8 937例,18.29%)、乳腺癌(7 583例,15.52%)、宫颈癌(5 121例,10.48%)、鼻咽癌(4 915例,10.06%)及直肠癌(2 814例,5.76%)。前5大病种累计占比达60.11%,其他病种包括口腔癌、脑部肿瘤、食管癌、淋巴瘤和肝癌等占比为39.89%。依据《湘医保发〔2025〕18号》文件,湖南省放疗类医疗服务项目一类价格

单次收费标准为: IMRT/3D-CRT 1 860 元/次, VMAT 2 420 元/次, TOMO 3 350 元/次, SBRT 7 000 元/次; 二类收费标准为: IMRT/3D-CRT 1 670 元/次, VMAT 2 170 元/次, TOMO 3 010 元/次, SBRT 6 300 元/次; 三类收费标准为: IMRT/3D-CRT 1 500 元/次, VMAT 1 950 元/次, TOMO 2 710 元/次, SBRT 5 670 元/次。上述技术均纳入医保乙类支付范围。本研究依据各病种临床常规治疗疗程设定参考模型(如常规 IMRT

方案按 25~33 次计, SBRT 方案按 5 次计), 标准化测算的各技术路径预估总费用分布见图 7B。SBRT 单次费用最高(7 000 元/次); TOMO 技术在鼻咽癌治疗中总费用最高(约 10 万元), 显著高于其他技术。VMAT 技术费用高于 IMRT 技术。从病种维度看, 鼻咽癌由于放疗次数多, 放疗预估总费用普遍高于乳腺癌、宫颈癌及直肠癌。

表 1 湖南省各市(州)放疗设备情况表

Table 1 Overview of radiotherapy equipment by city and prefecture in Hunan Province.

地区	单位数	人口/万人	加速器/台	伽马刀/台	后装机/台	模拟定位机/台	加速器/(台·百万人 ⁻¹)
长沙市	18	1 005	29	6	7	20	2.89
常德市	11	528	12	0	4	9	2.27
郴州市	6	467	8	1	2	6	1.71
株洲市	6	390	7	1	2	4	1.79
张家界市	2	152	2	0	0	1	1.32
怀化市	6	459	8	0	2	6	1.74
益阳市	4	385	6	0	3	5	1.56
湘潭市	3	273	3	0	2	4	1.10
衡阳市	9	665	9	0	2	6	1.35
岳阳市	7	505	10	1	3	4	1.98
永州市	5	529	7	1	1	4	1.32
湘西土家族苗族自治州	2	249	3	0	2	4	1.20
邵阳市	7	656	7	2	2	8	1.07
娄底市	4	383	4	0	1	4	1.04
全省	90	6 644	115	12	33	85	1.73

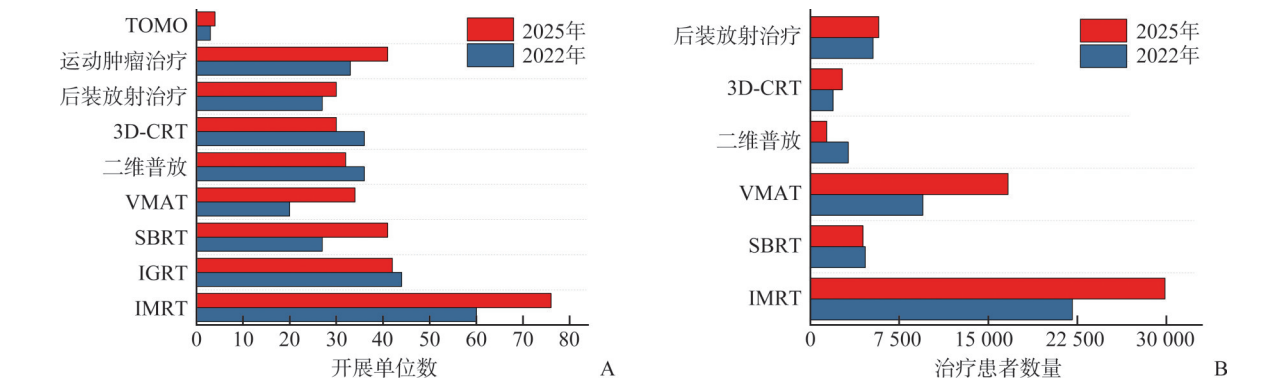


图 6 湖南省不同等级医院技术开展单位数(A)和治疗患者数量(B)
Figure 6 Number of technical operation units (A) and the number of treated patients (B) in different levels of hospitals in Hunan Province

3D-CRT: Three-dimensional conformal radiotherapy; VMAT: Volumetric modulated arc therapy; SBRT: Stereotactic body radiotherapy; IGRT: Image guided radiation therapy; IMRT: Intensity modulated radiation therapy.

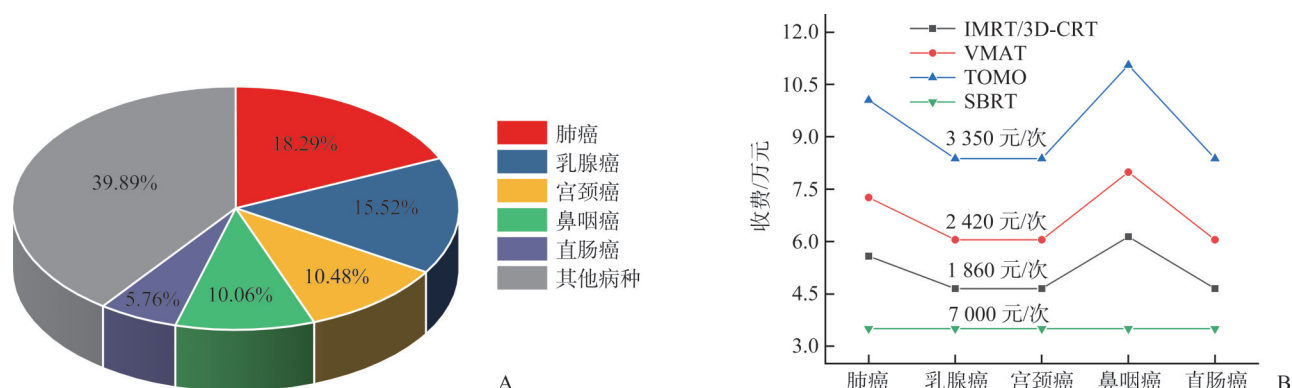


图7 湖南省2025年放疗主要病种构成与标准化治疗费用分析

Figure 7 Analysis of the distribution of major diseases and standardized radiotherapy costs in Hunan Province on 2025

A: Proportion of patients treated for major disease types. B: Estimated treatment costs by technical pathway under tier-1 pricing. Total costs represent standardized estimates based on routine clinical pathways. Actual costs may vary due to individual patient conditions, adjustments in treatment protocols, and inter-institutional variations in clinical pathways; these data are provided for reference only.

3 讨论

本研究调查结果显示2025年湖南省放疗领域在规模与技术能级上均实现显著增长。直线加速器数目较2022年增长30.59%，标志着省内放疗服务覆盖面进一步扩大^[8]。然而，全省每百万人口加速器拥有量(1.73台)仍远低于发达国家(6~12台)及国内先进省市(如北京3.59台)水平^[10-13]。参照国际原子能机构(International Atomic Energy Agency, IAEA)建议，每台加速器年适宜收治量约为500人^[14-17]。面对持续增长的肿瘤发病率，放疗资源的可及性与充足性仍面临挑战^[18-22]。基于此，本研究将从资源分布均衡性、人才梯队建设、设备技术更迭、临床技术应用及卫生经济保障5个维度展开深入讨论。

放疗服务的均衡化与资源下沉趋势分析的调研结果显示，全省放疗单位增至90家，地市级医院收治量占比升至29.3%，呈现明显的资源下沉趋势。这主要得益于2个方面：一是政策驱动与质控网络完善，为基层硬件扩张提供了标准与保障；二是就医模式转型，非省会医院硬件更新缩短了患者诊疗半径。尽管如此，区域间(如长沙与娄底、邵阳)资源配置仍存在一定差距，未来需通过分级诊疗与对口支援进一步实现同质化发展^[23]。

放疗从业人员结构与职业发展挑战分析结果显示，全省放疗从业人员职称结构呈高准入门槛特征，但岗位分布存在失衡。与全国2019年调查医师与物理师比例(3.51:1.00)相比，湖南省物理师与医师的比例略高于全国平均水平^[24-26]。物理师职称晋升通道不畅限制了高端人才留存；技师群体初级职称占比过

半(50.58%)，梯队建设尚处初期^[27-29]。尤为突出的是，专职维修工程师严重匮乏(仅60人)，对高精密设备的运行安全构成潜在风险。构建科学的职称评价体系、加强物理师与技师的专项规范化培训是保障高质量发展的核心。

放疗设备配置的更迭与保障能力分析结果显示，全省放疗设备已基本实现从常规模拟向CT影像引导的转型。值得关注的是，国产加速器市场份额升至14.41%，反映了本土高端医疗器械的临床认可度提升^[30]。此外，剂量仪与验证设备数量翻倍增长，体现了全省对放疗质控重视程度的跨越式提升，为临床安全提供了坚实保障。

放疗服务供给与患者经济负担的适配性分析结果显示，目前，湖南省已形成以IMRT为核心，IGRT、SBRT及VMAT多技并存的精准放疗体系。随着2025年8月高端技术(如TOMO)正式纳入医保支付范围^[9]，预计高精度放疗的普及率将进一步提高。调研发现，资源增长与省内癌情谱(肺癌、乳腺癌等)具有高度适配性，三级医院的资源集聚效应确保了复杂病例的精准覆盖。2025年放疗服务价格政策调整，在促进高精度放疗技术临床推广的同时，减轻了患者经济负担，进一步提升了先进放疗技术的可及性与可负担性。这种政策导向不仅减轻了患者的经济负担，更显著提升了先进技术的临床转化效率，具有显著的社会效益。

湖南省放疗事业虽进步显著，但仍面临资源分布不均、基层保障能力薄弱等挑战。未来应持续推动技术下沉与远程质控，加速设备国产化替代，构建公平、高效、精准的区域性放疗服务体系。

志谢:感谢湖南省卫生健康委员会医政处、湖南省肿瘤诊疗质量控制中心、湖南省内14个市州肿瘤诊疗质量控制中心、湖南省肿瘤医院、中南大学湘雅医院、湖南省医学会物理技术学组等机构对本次调查分析的大力支持。

作者贡献声明:徐运超、窦钰姣 数据分析, 论文综述、撰写及修改; 黄仕雄、杨敬儒、杨锬、李忠伟、金和坤、李影子、黄钢 数据采集; 师颖瑞 论文设计、指导及修改; 曾彪 论文指导与审校。所有作者阅读并同意最终的文本。

利益冲突声明:作者声称无任何利益冲突。

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(责任编辑 宋柳)