

Petition to State Health Coordinating Council

Adjustment to the Linear Accelerator Need Included in the Proposed 2026 State Medical Facilities Plan

July 23, 2025

Petitioner: CaroMont Health, Inc. ("CaroMont Health")
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Statement of Requested Change

CaroMont Health requests a need determination for one additional linear accelerator in Service Area 6 in the *2026 State Medical Facilities Plan ("SMFP")*.

Background

CaroMont Health, originally founded as Gaston Memorial Hospital in 1945, has evolved into one of the premier community-based healthcare systems in North Carolina, offering advanced medical services and a strong commitment to patient-centered care. Within this framework, CaroMont Health's cancer services have become a central pillar of its broader mission. Anchored by the CaroMont Cancer Center and associated specialty practices like CaroMont Hematology & Oncology, the oncology program exemplifies the institution's commitment to delivering exceptional, multidisciplinary cancer care close to home. The CaroMont Cancer Center is not merely a treatment location, it represents an integrated ecosystem that includes prevention, diagnostics, treatment, survivorship, research and palliative care. It was purposefully designed to reduce barriers to care, centralizing a comprehensive suite of services including medical oncology, radiation oncology, infusion therapy, social services, patient navigation, and more, under one roof. The physical location adjacent to the main hospital facilitates seamless coordination across specialties, including surgery, pathology and interventional radiology. CaroMont Health's community-driven approach is further reflected in its outreach programs, support groups, and partnerships with regional health networks, ensuring that its cancer care services are not only clinically robust but also compassionate and culturally responsive.

Since 2019, CaroMont Health, as a whole, has experienced a 20.2% increase $[(1,046 - 870) / 870 = 20.2\%]$ in radiation oncology patients and a 13.3% increase $[(22,293 - 19,678) / 19,678 = 13.3\%]$ in ESTV procedures. However, the two linear accelerators located in Gaston County at the CaroMont Cancer Center are severely constrained in their ability to serve additional patients due to their current ESTV utilization of 8,534 ESTVs per linear accelerator $[17,067 / 2 = 8,534]$ or 26.4% over $[8,534 - 6,750 / 6,750 = 26.4\%]$ the SMFP-defined linear accelerator capacity of 6,750 ESTVs.

Additionally, for the past two years, CaroMont Regional Medical Center has been treating osteoarthritis patients with low-dose radiation therapy (LDRT) utilizing the linear accelerators in the CaroMont Cancer Center. Based on recent studies and CaroMont Health's own experience, LDRT provides moderate to long-term pain relief and improvement in mobility after treatment. Treatment typically involves six, 10-minute, LDRT sessions over one to two weeks. Currently, LDRT is billed under CPT Code 77331, which is not included in the License Renewal Application for Hospitals or Table 15C-3: Linear Accelerator Treatment Data in the State Medical Facilities Plan. As a result, these treatments, which benefit osteoarthritis patients, are not considered for the purpose of linear accelerator utilization.

Reason for the Proposed Change

CaroMont Health is submitting this petition to the State Health Coordinating Council requesting an adjustment to the need determination for linear accelerators in Service Area 6. Chapter 15 of the *Proposed 2026 SMFP* identifies a surplus of 0.19 linear accelerators for Service Area 6, which includes Cleveland, Gaston, Lincoln and Rutherford counties. (Attachment 1)

Table 15C-5: Linear Accelerator Service Areas and Calculations

Service Area	2025 Population	Accelerators	Population within Service Area Per Accelerator	Percentage of Patients from Outside the Service Area	2023-2024 ESTV Procedures	Procedures Per Accelerator	ESTV Procedures Divided by 6,750 Minus # of Accelerators	Need Determinations
Area 1	147,896	2	73,948	5.14%	2,885	1,443	-1.57	
Area 2	447,717	7	63,960	16.36%	33,283	4,755	-2.07	
Area 3	99,198	1	99,198	11.67%	3,743	3,743	-0.45	
Area 4	176,914	3	58,971	13.36%	11,308	3,769	-1.32	
Area 5	380,081	6	63,347	10.72%	21,171	3,529	-2.86	
Area 6	513,589	5	102,718	8.85%	32,449	6,490	-0.19	
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Area 14**	237,979	6	39,663	77.17%	41,413	6,902	0.14	
Area 15	207,715	2	103,858	17.05%	11,284	5,642	-0.33	
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Area 21***	147,949	1	147,949					
Area 22*	256,176	2	128,088	39.30%	11,459	5,730	-0.30	
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Totals	11,107,246	132	84,146		662,401	5,018	-33.87	1

* Service Area has at least 120,000 base population per accelerator.

** Area has more than 45% of its patients coming from outside the service areas.

*** Service Area has one LINAC under development.

Proposed 2026 SMFP Linear Accelerator Need Methodology

The *Proposed 2026 SMFP* identifies a surplus of 0.19 linear accelerators. This linear accelerator surplus results in no need determination of additional linear accelerators in Service Area 6. The need methodology contains three criteria, two of which must be met in order for a deficit to become a need determination. The following summarizes the three criteria relative the Service Area 6:

Criterion 1 – Population per Linear Accelerator

Criterion 1 requires a service area to have a population base of 120,000 per linear accelerator before this criterion can be met. The *Proposed 2026 SMFP* shows that Service Area 6 has a current population of 513,589 or 102,718 per linear accelerator; as a result, Service Area 6 does not meet this criterion. In order for Service Area 6 to meet Criterion 1, Service Area 6 must first reach an overall population of 600,000 or an increase of 86,000 residents. Based on current NC Office of State Budget Management projections, this population would be achieved in 2050. (Attachment 2)

County	Population as of July 1, 2025	Population as of July 1, 2030	Population as of July 1, 2035	Population as of July 1, 2040	Population as of July 1, 2045	Population as of July 1, 2050
Cleveland	101,775	104,974	108,169	111,365	114,561	117,757
Gaston	247,108	259,477	268,203	274,362	278,710	281,776
Lincoln	99,351	108,247	116,016	123,549	131,028	138,499
Rutherford	65,355	65,932	66,045	66,063	66,067	66,066
Service Area 6	513,589	538,630	558,433	575,339	590,366	604,098

Source: <https://www.osbm.nc.gov/facts-figures/population-demographics/state-demographer/countystate-population-projections/population-overview>

Criterion 2 – 45% of Patients Residing Outside of Service Area 6

Criterion 2 requires a service area to have over 45% of its patients receiving linear accelerator services originate or reside outside of the service area. The *Proposed 2026 SMFP* shows that Service Area 6 has 8.85% of its patients residing outside of the service area; as a result, Service Area 6 does not meet this criterion. Currently, only two service areas, Service Area 14 which includes UNC Hospitals and Service Area 16 which includes Duke University Hospital, meet this criterion. Only one other service area, Service Area 22 (Johnston County), is within 9 percentage points of meeting Criterion 2.

Based on the historical service area patient origin for Service Area 6, Service Area 6 cannot reasonably project to reach the 45% threshold at any time in the foreseeable future. The following table shows that Service Area 6 has maintained a percentage of service area patients originating from outside of the service area below 11%.

	2022 SMFP	2023 SMFP	2024 SMFP	2025 SMFP	Proposed 2026 SMFP
Patient Origin Outside of Service Area 6	8.19%	9.85%	10.10%	10.67%	8.85%

Source: 2022 – *Proposed 2026 SMFP* (Attachment 3)

Criterion 3 – Linear Accelerator Deficit

Criterion 3 requires a service area to have a linear accelerator deficit of greater than or equal to 0.25. The *Proposed 2026 SMFP* shows that Service Area 6 has a linear accelerator surplus of 0.19 linear accelerators; as a result, Service Area 6 does not meet this criterion.

Service Area 6 and Criterion 1 Consideration

Although Criterion 1 requires a service area to have a population base of 120,000 per linear accelerator before this criterion can be met, this population base was originally recommended by the Inter-Society Council for Radiation Oncology (which no longer exists), in its "Blue Book" dated December 1991. This recommendation is also currently **rejected** by the American Society for Therapeutic Radiology and Oncology. (Attachment 4)

Additionally, the population base of 120,000 per linear accelerator specifically assumes "that 4.1 newly diagnosed cancers will be detected per year per 1,000 people." This rate results in 492 diagnosed cancers with 50% or 245-250 requiring radiation therapy, annually. The most recent Cancer Incidence rates provided by the Central Cancer Registry and the NCDHHS Division of Public Health NC State Center for Health Statistics (Attachment 5) on its website indicate that every county in Service Area 6 has a cancer incidence rate of newly diagnosed cancers detected per year per 1,000 people equal to or over 4.1 per 1,000 as the following tables highlight:

2021 Cancer Incidence Rate per 1,000 People

Service Area 6 County	Cases	Rate per 100,000	Converted Rate per 1,000*
Cleveland	706	536.5	5.4
Gaston	1,563	546.7	5.5
Lincoln	635	504.3	5.0
Rutherford	548	573.6	5.7

* Converted Rate per 1,000 = Rate per 100,000 / 100

Source: Central Cancer Registry, January 2024.

2019-2023 Cancer Incidence Rate per 1,000 People

Service Area 6 County	Cases	Rate per 100,000	Converted Rate per 1,000*
Cleveland	3,428	511.5	5.1
Gaston	7,562	530.0	5.3
Lincoln	3,082	492.7	4.9
Rutherford	2,446	500.8	5.0

* Converted Rate per 1,000 = Rate per 100,000 / 100

Source: NC State Center for Health Statistics, March 2025.

Service Area 6 and CaroMont Health Considerations

CaroMont Health is the largest provider of linear accelerator services in Service Area 6. In FY2024, CaroMont Health, as a whole, provided 22,293 ESTV procedures, while Atrium Health Cleveland provided 6,657 ESTV procedures and NC Radiation Management-Forest City provided 3,499 ESTV procedures. As previously stated, the CaroMont Cancer Center is one of the most complete cancer care programs in North Carolina. In order to accommodate the volume of procedures performed on its two linear accelerators located at CaroMont Regional Medical Center in Gaston County (17,067 ESTV in FY2024), CaroMont Health has had to increase patient throughput and internal efficiencies. CaroMont Health is scheduling patients every 15 minutes on its two linear accelerators. **As a result, these two linear accelerators are performing more ESTV procedures per linear accelerator than any other linear accelerator provider in North Carolina that provides at least 13,500 ESTV procedures per year.** The following table highlights the 15 linear accelerator providers in North Carolina that provide at least 13,500 ESTV procedures per year. (Attachment 6)

Facility	Linear Accelerators	Total ESTV Procedures	ESTV Procedures per Linear Accelerator	% Different from CRMC
CaroMont Regional Medical Center	2	17,067	8,534	0.0%
Cone Health Wesley Long Hospital	4	31,476	7,869	7.8%
New Hanover Regional Medical Center	5	38,950	7,790	8.7%
UNC Hospitals	6	41,413	6,902	19.1%
Matthews Radiation Oncology	2	13,722	6,886	19.3%
Duke Raleigh Hospital	4	27,461	6,865	19.6%
Atrium Health Carolinas Medical Center	3	19,787	6,596	22.7%
Atrium Health Wake Forest Baptist Medical Center	4	22,986	5,747	32.7%
Vidant Radiation Oncology	3	17,234	5,745	32.7%
UNC Health Rex	4	22,543	5,636	34.0%
Duke University Hospital	8	43,378	5,422	36.5%
Mission Hospital	3	16,081	5,360	37.2%
Novant Health Forsyth Medical Center	5	26,736	5,347	37.3%
Atrium Health Cabarrus	3	13,895	4,632	45.7%
Cape Fear Valley Medical Center	5	17,919	3,584	58.0%

As the previous table indicates, CaroMont Health is the 12th largest provider of linear accelerator services based on total ESTV procedures in North Carolina. More telling is that of the 11 larger linear accelerator providers based on ESTV procedures in North Carolina, **CaroMont Health in Gaston County is the only linear accelerator provider utilizing only two linear accelerators to treat patients.** The three linear accelerator providers that provide a total number of ESTV procedures similar to CaroMont Health, Cape Fear Valley Medical Center, Mission Hospital, and Vidant Radiation Oncology, each operate three or more linear accelerators. In fact, comparing the 11 larger linear accelerator providers to CaroMont Health, seven of the 11 linear accelerator providers performed 20% or more **fewer** ESTV procedures per

linear accelerator and all providers operated three or more linear accelerators. On the opposite end of the spectrum from CaroMont Health, Cape Fear Valley Medical Center performed 17,919 ESTV procedures on 5 linear accelerators. Whereas CaroMont Health is operating at 126.4% of capacity $[(17,067 / (2 \times 6,750)) = 126.4\%]$, Cape Fear Valley Medical Center is operating at 53.1% of capacity $[(17,919 / (5 \times 6,750)) = 53.1\%]$.

Service Area 6 Update Consideration

In an email exchange with Andrea Emanuel, Assistant Section Chief, (**Attachment 7**) the patient origin data from the current reporting year (10/1/23 to 9/30/24) will not be made publicly available until late September/early October. As a result, CaroMont Health is relying on patient origin data from the previous reporting year (10/1/22 to 9/30/23) that is publicly available at <https://info.ncdhhs.gov/dhsr/mfp/publications.html#por>.

The third Assumptions of the Methodology found on page 298 of the Proposed 2026 SMFP defines the linear accelerator service areas, as shown below.

3. Patient origin data from the current reporting year forms the basis for defining service areas (*Table 15C-4*). Counties are the basic units for the formation of linear accelerator service areas, based on proximity, utilization patterns, and patient origin data. A small percentage of the population lives some distance from a linear accelerator, but the sparsity of population in and around these areas does not provide the population required to support a linear accelerator. In these cases, two exceptions apply:
 - a. Where patient origin data indicates a county's residents primarily use a linear accelerator that is outside their home county, the county is aligned with the county where at least 45% of its residents go for linear accelerator services.
 - b. When a county with a linear accelerator has a population less than 120,000, that county is combined with an adjacent county to which the largest percentage of patients go for linear accelerator services, based on patient origin data.

3.a. states that when a county's residents primarily use a linear accelerator that is outside their home county, the county is aligned with the county where at least 45% of its residents go for linear accelerator services. The publicly available data indicates that 68.94% of Lincoln County linear accelerator patients go to Catawba County for linear accelerator services. If this percentage has not changed in the last year, then Lincoln County should be aligned into Linear Accelerator Service Area 5.

3.b. states that when a county with a linear accelerator has a population less than 120,000, that county is combined with an adjacent county to which the largest percentage of patients go for linear accelerator services. The publicly available data indicates that 12.98% of Rutherford County linear accelerator patients go to Buncombe County for linear accelerator services. If this percentage has not changed in the last year, then Rutherford County should be aligned into Linear Accelerator Service Area 2.

Linear Accelerator Service Area 6 would then only include Cleveland and Gaston counties.

This update would result in a 0.51 linear accelerator deficit in Service Area 6 but would not result in a linear accelerator need determination in Service Area 6 because of having only 116,296 population per linear accelerator, as the following table indicates.

Service Area	2025 Population	Accelerators	Population within Service Area Per Accelerator	Percentage of Patients from Outside the Service Area	2023-2024 ESTV Procedures	Procedures Per Accelerator	ESTV Procedures Divided by 6,750 Minus # of Accelerators	Need Determination
Area 6	348,883	3	116,294	*	23,724	7,908	0.51	

* An updated Percentage of Patients from Outside the Service Area could not be calculated.

CaroMont Health specifically requests that the need for linear accelerators in Service Area 6 be adjusted based on the following data and result in a need determination in the 2026 SMFP for one (1) linear accelerator in Service Area 6.

Updated Service Area 6 Linear Accelerator Deficit

The Updated Service Area 6 would consist of two linear accelerator providers, CaroMont Health (2 linear accelerators) and Atrium Health Cleveland (1 linear accelerator). The following table shows the facility linear accelerator surplus or deficit in the Updated Service Area 6 over the past two SMFPs.

	Updated Service Area	Accelerators	ESTV Procedures	Procedures Per Accelerator	ESTV Procedures Divided by 6,750 Minus # of Accelerators	Need Determinations
2024 SMFP	CaroMont Health	2	16,156	8,078	0.39	
	Atrium Health Cleveland	1	6,561	6,561	-0.03	
	Area 6	3	22,717	7,572	0.37	1
2025 SMFP	CaroMont Health	2	17,211	8,606	0.55	
	Atrium Health Cleveland	1	7,097	7,097	0.05	
	Area 6	3	24,308	8,103	0.60	1
Proposed 2026 SMFP	CaroMont Health	2	17,067	8,534	0.53	
	Atrium Health Cleveland	1	6,657	6,657	-0.01	
	Area 6	3	23,724	7,908	0.51	1

Source: 2024 – Proposed 2026 SMFP

As the previous tables indicate, CaroMont Health on its own would generate a need, but since the need methodology requires Atrium Health Cleveland's linear accelerator need to be considered, the need methodology would still generate a need determination in the Updated Service Area 6.

Statement of the Adverse Effects on Providers or Consumers if the Change is Not Made

CaroMont Health has had to make many operational adjustments to accommodate its radiation therapy patients on just two linear accelerators in Gaston County, while taking many concerns into consideration, as the following points highlight:

1. CaroMont Health extended the treatment day from 7:30am-4:30pm to 7:00am-6:00pm and some days later to 6:30pm to increase treatment capacity on the linear accelerators. This requires daily linear accelerator check-ins starting as early as 6:00am with treatments throughout the day, which has eliminated the “lunch block hour” and now requires rotating lunches, when possible.
2. CaroMont Health also schedules patients in 15-minute treatment blocks but will double book a treatment block if two patients can be treated within that time period.
3. CaroMont Health’s patient population in Gaston County tends to be older, frailer, and sicker, and they are often unable to drive in the dark and cannot arrive before sunrise or depart after sunset.
4. Based on the recent studies by ASCO (2019) and ASRT (2022), CaroMont Health’s volume of patients per linear accelerator greatly exceeds national norms. (Attachment 8)
 - National Average: 22.3 patients per day, per linear accelerator
 - CaroMont Health Average: 65-70 patients per day or 32-35 patients per linear accelerator
 - National Average: 5,237 treatments administered per year, per linear accelerator
 - CaroMont Health Average: 8,534 treatments administered per year, per linear accelerator
5. In 2019, CaroMont Health and its physicians established policies and procedures limiting the waiting period for initiating treatments to 3-6 days, depending on the treatment (e.g. IMRT, SRS, SBRT, 3D, etc.), from an average of two weeks. This policy decreases patient anxiety due to delayed cancer treatment but adds stress to the linear accelerators’ operation.

Statement of Alternatives Considered and Found Not Feasible

CaroMont Health has already implemented the following alternatives over the last several years to increase patient throughput and linear accelerator capacity but the need for a third linear accelerator at the CaroMont Cancer Center remains.

- Eliminated downtime between patients
- Double booked treatment blocks, when possible
- Extended operating hours
- Upgraded existing linear accelerators to include HyperSight, HyperArc, and 6 Degree of Freedom couches

The following alternatives have been considered but found to be less effective.

- Mobile Linear Accelerator: Several diagnostic and treatment modalities are available via mobile technology; however, mobile linear accelerators do not operate in North Carolina.
- Collaboration with Other CaroMont Health locations: CaroMont Health operates a linear accelerator in Lincoln County, however, this location does not offer the full complement of radiation therapy treatments as offered at the CaroMont Cancer Center and it also focuses on residents of Lincoln County. In addition, this location is 30 minutes from CaroMont Cancer Center and patients are usually reluctant to travel that distance for treatments, unless forced to by their situation.

Developing a third linear accelerator is the only effective alternative to meet the needs of CaroMont Health radiation therapy patients.

No Unnecessary Duplication of Health Resources

The proposed special need adjustment for Service Area 6 will require any applicant to meet the utilization performance standards in 10A NCAC 14C .1903(3). As a result, the special need adjustment would not result in unnecessary duplication of health resources in the service area.

Based on the performance standard required to operate an additional linear accelerators, 10A NCAC 14C .1903(5)(a) and (b) requires an applicant to project that the LINACs identified in Items (1) and (2) of this Rule and the proposed LINAC shall perform during the third full fiscal year of operation following completion of the project either: 6,750 or more ESTVs per LINAC; or serve 250 or more patients per LINAC.

Currently, CaroMont Health's existing ESTV procedures workload in Gaston County meets over 84% [$17,067 / 3 = 5,689$; $5,689 / 6,750 = 84.3\%$] of that requirement already. In comparing the other 14 linear accelerator providers on page 6 to CaroMont Health, five of the 14 linear accelerator providers provide 6,750 ESTV procedures or more per linear accelerator and nine of the 14 linear accelerator providers performed 6,750 ESTV procedures or less per linear accelerator.

Evidence that the Proposed Change is Consistent with the Three Basic Principles Governing the Development of the SMFP: safety and quality, access, and value.

Supporting the adjusted need determination for an additional linear accelerator in Linear Accelerator Service Area 6 aligns with the core tenets of the SMFP: enhancing safety and quality, improving access, and delivering greater healthcare value.

1. Safety and Quality

The introduction of a third linear accelerator at CaroMont Health will directly advance patient safety and the overall quality of care in several keyways:

- **Reduced Treatment Delays:** By expanding its radiation therapy capacity, CaroMont Health will be better positioned to manage increasing patient volumes, resulting in less linear accelerator operational stress in meeting established treatment initiation standards. Prompt access to radiation therapy has been linked to better clinical outcomes and improved patient satisfaction.
- **Increased Precision and Scheduling Flexibility:** An additional linear accelerator will provide more flexibility in scheduling, allowing clinicians to tailor treatment delivery more efficiently. This will support the consistent use of advanced, high-precision radiation techniques, thereby optimizing therapeutic outcomes.
- **Operational Continuity:** With a third machine in place, CaroMont Health will strengthen its ability to maintain uninterrupted services during equipment maintenance or unexpected downtime. This added redundancy will ensure that patient care remains consistent and reliable, even when one unit is temporarily offline.

2. Access

Enhancing the availability of radiation therapy services in Service Area 6 will significantly improve patient access to timely care:

- **Expanded Treatment Capacity:** The addition of a third linear accelerator will allow CaroMont Health to serve more patients without extending appointment lead times. This is especially critical for patients whose treatment schedules require multiple consecutive sessions.
- **Responding to Population Growth and Aging:** Service Area 6, which includes Gaston and neighboring counties, is experiencing ongoing population increases and the aging population which is contributing to higher demand for oncology services. A third linear accelerator will help ensure that CaroMont Health can meet this rising need without compromising service availability.

3. Value

The proposed expansion also supports the SMFP's goal of promoting value in healthcare delivery:

- **Improved Operational Efficiency:** Increasing the number of linear accelerators at CaroMont Health will allow the facility to operate more efficiently by distributing patient volume more evenly. This scale of operation can lower per-treatment costs over time and maximize utilization rates, ultimately contributing to a more cost-effective care model.

Summary

CaroMont Health is requesting an adjusted need determination of one (1) linear accelerator for Service Area 6 in the *Proposed 2026 SMFP*.

Please refer to **Attachment 9** for a letter from CaroMont Health radiation oncologists (SERO) who validate the need for an additional linear accelerator in Service Area 6 and more specifically at CaroMont Cancer Center.

CaroMont Health appreciates the SHCC and staff's time and attention and is pleased to answer any questions.

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*** Service Area has one LINAC under development.

Attachment 2

County	Population as of July 1, 2020	Population as of July 1, 2025	Population as of July 1, 2030	Population as of July 1, 2035	Population as of July 1, 2040	Population as of July 1, 2045	Population as of July 1, 2050	Population as of July 1, 2055	Population as of July 1, 2060
Alamance	172,348	185,255	195,390	205,528	215,665	225,801	235,937	246,073	256,210
Alexander	36,343	36,525	36,815	36,885	36,901	36,904	36,906	36,907	36,904
Alleghany	10,928	11,672	11,728	11,729	11,730	11,729	11,729	11,730	11,728
Anson	21,953	21,453	21,198	21,077	21,023	20,998	20,985	20,979	20,979
Ashe	26,558	26,578	26,578	26,579	26,578	26,578	26,577	26,579	26,577
Avery	17,692	17,555	17,558	17,558	17,557	17,558	17,558	17,558	17,557
Beaufort	44,529	43,904	43,829	43,820	43,819	43,819	43,820	43,818	43,820
Bertie	17,765	16,543	16,058	15,820	15,706	15,650	15,623	15,609	15,602
Bladen	29,497	29,807	31,514	33,369	35,281	37,254	39,264	41,308	43,371
Brunswick	138,756	175,047	201,455	221,669	239,871	257,422	274,760	292,031	309,279
Buncombe	270,046	283,020	297,951	312,882	327,812	342,746	357,675	372,610	387,540
Burke	87,761	91,032	91,881	92,007	92,044	92,034	92,049	92,034	92,048
Cabarrus	227,580	250,391	275,787	298,585	323,521	346,935	371,319	395,147	419,252
Caldwell	80,836	82,606	83,140	83,237	83,255	83,258	83,258	83,260	83,256
Camden	10,402	10,720	11,188	11,817	12,470	13,128	13,783	14,441	15,097
Carteret	68,032	71,314	73,692	76,009	78,322	80,636	82,950	85,263	87,576
Caswell	22,640	22,460	22,461	22,461	22,461	22,462	22,461	22,461	22,461
Catawba	161,130	169,918	179,219	188,523	197,826	207,128	216,429	225,732	235,036
Chatham	76,457	84,127	90,949	97,773	104,594	111,419	118,238	125,061	131,885
Cherokee	28,758	30,152	31,303	32,455	33,605	34,754	35,909	37,058	38,209
Chowan	13,684	13,758	13,759	13,758	13,757	13,757	13,758	13,759	13,758
Clay	11,128	12,108	12,841	13,536	14,227	14,918	15,610	16,302	16,993
Cleveland	99,452	101,775	104,974	108,169	111,365	114,561	117,757	120,953	124,149
Columbus	50,419	51,555	53,859	53,235	52,524	52,791	53,014	52,903	52,836
Craven	101,229	103,335	103,334	103,335	103,336	103,335	103,335	103,336	103,335
Cumberland	336,668	337,972	337,971	337,971	337,972	337,971	337,971	337,971	337,971
Currituck	28,421	32,865	36,487	40,111	43,736	47,360	50,982	54,606	58,230
Dare	37,151	38,274	39,652	41,834	44,583	47,724	51,149	54,766	58,521
Davidson	169,620	180,480	188,246	195,154	201,945	208,718	215,494	222,268	229,040
Davie	42,820	45,374	48,186	50,996	53,808	56,619	59,431	62,241	65,052
Duplin	48,567	50,354	53,298	56,239	59,181	62,126	65,068	68,008	70,953
Durham	326,546	344,427	365,472	387,669	410,039	432,438	454,842	477,242	499,649
Edgecombe	48,833	48,556	48,691	48,723	48,730	48,731	48,732	48,732	48,731
Forsyth	383,952	398,434	414,897	432,650	450,646	468,692	486,746	504,803	522,859
Franklin	69,121	83,010	94,444	103,982	112,525	120,549	128,298	135,905	143,437
Gaston	229,299	247,108	259,477	268,203	274,362	278,710	281,776	283,944	285,469
Gates	10,438	10,294	10,293	10,293	10,292	10,292	10,293	10,292	10,292
Graham	8,005	8,023	8,067	8,081	8,087	8,087	8,090	8,088	8,091
Granville	60,913	62,753	66,497	70,245	73,991	77,738	81,486	85,231	88,979
Greene	20,333	20,145	20,145	20,147	20,146	20,143	20,146	20,146	20,145
Guilford	542,304	560,760	592,680	615,140	640,864	666,232	691,150	716,482	741,605
Hallfax	48,422	45,806	43,925	42,106	40,304	38,499	36,700	34,896	33,096
Harnett	133,851	147,949	158,408	169,861	181,578	192,668	204,363	215,599	227,137
Haywood	62,281	64,805	66,945	69,086	71,227	73,365	75,507	77,646	79,788
Henderson	116,631	123,515	130,564	137,573	144,579	151,587	158,592	165,598	172,605
Hertford	21,073	18,335	17,524	16,806	16,063	15,347	14,603	13,889	13,143
Hoke	52,502	56,282	60,151	64,414	68,776	73,157	77,548	81,938	86,329
Hyde	4,593	4,588	4,334	4,074	3,819	3,560	3,303	3,046	2,787
Iredell	188,250	209,922	228,423	246,571	264,677	282,782	300,889	318,993	337,097
Jackson	42,811	45,035	46,937	48,842	50,744	52,647	54,551	56,452	58,355
Johnston	218,141	256,176	290,489	320,446	348,083	373,430	397,896	421,051	443,999
Jones	9,147	9,267	9,117	8,923	8,729	8,527	8,331	8,134	7,936
Lee	63,544	70,022	75,142	79,608	83,961	88,296	92,627	96,958	101,288
Lenoir	54,911	53,992	54,020	54,029	54,032	54,032	54,031	54,032	54,033
Lincoln	87,299	99,351	108,247	116,016	123,549	131,028	138,499	145,963	153,432
Macon	37,015	38,878	40,686	42,498	44,310	46,122	47,934	49,744	51,555
Madison	21,197	21,926	22,360	22,792	23,229	23,660	24,093	24,527	24,961
Martin	21,896	20,812	19,882	18,952	18,021	17,092	16,163	15,235	14,303

County	Population as of July 1, 2020	Population as of July 1, 2025	Population as of July 1, 2030	Population as of July 1, 2035	Population as of July 1, 2040	Population as of July 1, 2045	Population as of July 1, 2050	Population as of July 1, 2055	Population as of July 1, 2060
McDowell	44,451	44,739	44,816	44,818	44,817	44,817	44,816	44,817	44,818
Mecklenburg	1,118,967	1,198,460	1,293,761	1,390,256	1,486,855	1,583,467	1,680,076	1,776,688	1,873,298
Mitchell	14,862	14,641	14,438	14,235	14,031	13,830	13,627	13,423	13,222
Montgomery	25,690	26,105	26,192	26,194	26,195	26,194	26,195	26,194	26,196
Moore	100,585	112,620	124,746	136,414	148,540	160,210	172,334	184,005	196,130
Nash	95,267	99,191	101,336	102,390	102,907	103,159	103,286	103,345	103,375
New Hanover	226,927	246,073	262,570	279,084	295,596	312,111	328,626	345,139	361,652
Northampton	17,345	16,243	15,884	15,736	15,676	15,653	15,642	15,635	15,635
Onslow	205,746	218,432	230,898	243,360	255,825	268,290	280,753	293,218	305,682
Orange	148,695	153,852	161,200	168,548	175,896	183,246	190,593	197,941	205,290
Pamlico	12,254	12,889	12,917	12,915	12,918	12,917	12,919	12,917	12,918
Pasquotank	40,685	41,338	41,339	41,337	41,338	41,339	41,337	41,340	41,339
Pender	60,680	70,203	75,400	81,097	86,921	92,722	98,526	104,324	110,128
Perquimans	13,014	13,534	13,887	14,038	14,100	14,127	14,135	14,141	14,141
Person	39,065	39,906	40,729	41,572	42,411	43,252	44,090	44,929	45,770
Pitt	171,103	176,095	184,225	197,338	208,982	219,603	229,923	241,398	252,666
Polk	19,370	19,818	19,818	19,819	19,817	19,819	19,818	19,818	19,819
Randolph	143,899	148,749	152,672	156,377	160,079	163,783	167,482	171,185	174,886
Richmond	42,958	41,421	40,456	40,025	39,830	39,746	39,706	39,690	39,683
Robeson	116,310	116,081	116,606	119,456	123,424	127,852	132,459	137,139	141,849
Rockingham	90,910	92,415	92,415	92,415	92,417	92,416	92,416	92,416	92,416
Rowan	147,296	154,322	158,229	163,304	168,331	172,941	178,036	182,754	187,701
Rutherford	64,286	65,355	65,932	66,045	66,063	66,067	66,066	66,068	66,070
Sampson	58,849	60,665	61,899	62,238	62,331	62,356	62,364	62,366	62,367
Scotland	34,069	33,154	32,126	31,097	30,066	29,037	28,007	26,979	25,948
Stanly	62,402	65,587	67,060	68,536	70,007	71,478	72,952	74,422	75,897
Stokes	44,486	45,927	46,328	46,412	46,432	46,438	46,438	46,438	46,438
Surry	71,158	71,774	71,772	71,775	71,775	71,775	71,773	71,774	71,773
Swain	14,096	13,700	13,550	13,496	13,478	13,470	13,468	13,467	13,467
Transylvania	32,943	33,581	34,061	34,229	34,285	34,304	34,313	34,314	34,315
Tyrrell	3,268	3,480	3,479	3,482	3,480	3,480	3,479	3,479	3,479
Union	239,925	273,432	306,153	335,673	366,971	397,509	428,408	459,060	489,932
Vance	42,338	41,231	41,222	41,220	41,221	41,221	41,219	41,222	41,222
Wake	1,135,576	1,238,879	1,358,482	1,480,706	1,603,182	1,725,679	1,848,178	1,970,678	2,093,180
Warren	18,633	18,701	18,780	18,799	18,804	18,804	18,805	18,805	18,804
Washington	10,929	10,339	9,877	9,385	8,882	8,372	7,861	7,350	6,840
Watauga	54,271	55,065	55,141	55,155	55,158	55,158	55,159	55,160	55,159
Wayne	116,930	119,286	120,366	120,510	120,529	120,531	120,533	120,532	120,533
Wilkes	65,748	66,513	67,214	67,849	68,547	69,337	70,243	71,283	72,485
Wilson	78,859	79,042	79,283	79,342	79,352	79,357	79,356	79,356	79,356
Yadkin	37,138	37,722	37,723	37,722	37,723	37,724	37,723	37,722	37,722
Yancey	18,432	18,586	18,741	18,894	19,050	19,204	19,358	19,514	19,669
STATE	10,472,893	11,107,246	11,743,841	12,355,144	12,966,080	13,568,300	14,170,486	14,769,783	15,369,596

Table 15C-5: Linear Accelerator Service Areas and Calculations

Service Area	2025 Population	Accelerators	Population within Service Area Per Accelerator	Percentage of Patients from Outside the Service Area	2023-2024 ESTV Procedures	Procedures Per Accelerator	ESTV Procedures Divided by 6,750 Minus # of Accelerators	Need Determinations
Area 1	147,896	2	73,948	5.14%	2,885	1,443	-1.57	
Area 2	447,717	7	63,960	16.36%	33,283	4,755	-2.07	
Area 3	99,198	1	99,198	11.67%	3,743	3,743	-0.45	
Area 4	176,914	3	58,971	13.36%	11,308	3,769	-1.32	
Area 5	380,081	6	63,347	10.72%	21,171	3,529	-2.86	
Area 6	513,589	5	102,718	8.85%	32,449	6,490	-0.19	
Area 7*	1,493,345	12	124,445	22.12%	87,110	7,259	0.91	1
Area 8	364,244	4	91,061	27.57%	19,295	4,824	-1.14	
Area 9	315,978	4	78,995	23.76%	18,131	4,533	-1.31	
Area 10	677,416	10	67,742	26.52%	49,722	4,972	-2.63	
Area 11*	180,480	1	180,480	11.27%	3,233	3,233	-0.52	
Area 12	653,175	7	93,311	21.57%	43,551	6,222	-0.55	
Area 13*	148,749	1	148,749	11.61%	3,549	3,549	-0.47	
Area 14**	237,979	6	39,663	77.17%	41,413	6,902	0.14	
Area 15	207,715	2	103,858	17.05%	11,284	5,642	-0.33	
Area 16**	507,018	10	50,702	62.74%	50,863	5,086	-2.46	
Area 17	339,604	4	84,901	21.20%	10,351	2,588	-2.47	
Area 18	544,525	8	68,066	17.70%	27,658	3,457	-3.90	
Area 19	542,878	5	108,576	10.42%	38,950	7,790	0.77	
Area 20	1,321,889	12	110,157	16.71%	52,903	4,409	-4.16	
Area 21*/***	147,949	1	147,949					
Area 22*	256,176	2	128,088	39.30%	11,459	5,730	-0.30	
Area 23	223,632	2	111,816	9.49%	11,911	5,956	-0.24	
Area 24	196,805	4	49,201	16.03%	17,563	4,391	-1.40	
Area 25*	218,432	1	218,432	17.00%	6,811	6,811	0.01	
Area 26	288,838	4	72,210	5.19%	11,001	2,750	-2.37	
Area 27	310,761	6	51,794	30.75%	32,146	5,358	-1.24	
Area 28	164,263	2	82,132	6.07%	8,663	4,331	-0.72	
Totals	11,107,246	132	84,146		662,401	5,018	-33.87	1

* Service Area has at least 120,000 base population per accelerator.

** Area has more than 45% of its patients coming from outside the service areas.

*** Service Area has one LINAC under development.

Table 15C-5: Linear Accelerator Service Areas and Calculations

Service Area	2024 Population	Accelerators	Population within Service Area Per Accelerator	Percentage of Patients from Outside the Service Area	2022-2023 ESTV Procedures	Procedures Per Accelerator	ESTV Procedures Divided by 6,750 Minus # of Accelerators	Need Determinations
Area 1	144,707	2	72,354	4.98%	3,400	1,700	-1.50	
Area 2	442,851	7	63,264	23.83%	31,140	4,449	-2.39	
Area 3	102,342	1	102,342	20.00%	1,934	1,934	-0.71	
Area 4	174,477	3	58,159	18.58%	12,158	4,053	-1.20	
Area 5	376,168	6	62,695	10.23%	20,880	3,480	-2.91	
Area 6	507,797	5	101,559	10.67%	34,058	6,812	0.05	
Area 7*	1,475,958	12	122,997	21.23%	81,748	6,812	0.11	
Area 8	360,729	4	90,182	19.07%	17,676	4,419	-1.38	
Area 9	313,152	4	78,288	24.35%	18,108	4,527	-1.32	
Area 10	673,692	10	67,369	29.21%	50,934	5,093	-2.45	
Area 11*	178,071	1	178,071	14.89%	2,815	2,815	-0.58	
Area 12	644,594	7	92,085	21.87%	44,299	6,328	-0.44	
Area 13*	146,358	1	146,358	9.93%	3,537	3,537	-0.48	
Area 14**	234,135	6	39,023	75.14%	39,686	6,614	-0.12	
Area 15	206,074	2	103,037	19.69%	5,594	2,797	-1.17	
Area 16**	502,395	10	50,240	62.46%	51,302	5,130	-2.40	
Area 17	335,828	4	83,957	21.53%	20,678	5,170	-0.94	
Area 18	550,993	8	68,874	20.00%	27,860	3,483	-3.87	
Area 19	529,014	5	105,803	10.01%	34,265	6,853	0.08	
Area 20	1,293,613	12	107,801	11.13%	52,308	4,359	-4.25	
Area 21*/***	145,438	1	145,438		0	0	-1.00	
Area 22*	249,714	2	124,857	39.61%	11,486	5,743	-0.30	
Area 23	220,332	2	110,166	12.70%	11,610	5,805	-0.28	
Area 24	197,234	4	49,309	17.73%	16,110	4,028	-1.61	
Area 25*	214,782	1	214,782	17.76%	6,339	6,339	-0.06	
Area 26	285,994	4	71,499	4.80%	12,246	3,061	-2.19	
Area 27	313,021	6	52,170	27.96%	29,626	4,938	-1.61	
Area 28	164,643	2	82,322	3.03%	8,249	4,125	-0.78	
Totals	10,984,106	132	83,213		650,040	4,925	-35.70	

* Service Area has at least 120,000 base population per accelerator.

** Area has more than 45% of its patients coming from outside the service areas.

*** Service Area has one LINAC under development.

Table 15C-5: Linear Accelerator Service Areas and Calculations

Service Area	2023 Population	Accelerators	Population within Service Area Per Accelerator	Percentage of Patients from Outside the Service Area	2021-2022 ESTV Procedures	Procedures Per Accelerator	ESTV Procedures Divided by 6,750 Minus # of Accelerators	Need Determinations
Area 1	144,685	2	72,343	15.69%	3,339	1,670	-1.51	
Area 2	440,212	8	55,027	27.38%	33,093	4,137	-3.10	
Area 3	98,197	1	98,197	14.06%	2,336	2,336	-0.65	
Area 4	171,237	3	57,079	11.25%	11,251	3,750	-1.33	
Area 5	369,403	6	61,567	17.67%	21,492	3,582	-2.82	
Area 6	501,349	5	100,270	10.10%	31,413	6,283	-0.35	
Area 7	1,433,456	12	119,455	22.00%	76,757	6,396	-0.63	
Area 8	350,759	4	87,690	28.57%	20,341	5,085	-0.99	
Area 9	303,520	4	75,880	25.30%	16,615	4,154	-1.54	
Area 10	662,900	10	66,290	36.73%	33,830	3,383	-4.99	
Area 11*	173,876	1	173,876	20.57%	3,181	3,181	-0.53	
Area 12	638,925	7	91,275	20.23%	42,949	6,136	-0.64	
Area 13*	146,470	1	146,470	13.70%	3,884	3,884	-0.42	
Area 14**	230,834	6	38,472	74.69%	39,067	6,511	-0.21	
Area 15	201,188	2	100,594	17.91%	9,630	4,815	-0.57	
Area 16**	500,359	10	50,036	62.40%	50,202	5,020	-2.56	
Area 17	330,164	3	110,055	21.88%	20,355	6,785	0.02	
Area 18	550,660	8	68,833	13.45%	29,397	3,675	-3.64	
Area 19	513,357	5	102,671	11.58%	34,506	6,901	0.11	
Area 20	1,265,403	12	105,450	10.01%	49,329	4,111	-4.69	
Area 21*	143,081	1	143,081		0	0	-1.00	
Area 22*	242,959	2	121,480	43.45%	11,557	5,779	-0.29	
Area 23	220,500	2	110,250	13.79%	13,670	6,835	0.03	
Area 24	192,898	4	48,225	17.17%	16,726	4,182	-1.52	
Area 25*	212,036	1	212,036	17.75%	2,694	2,694	-0.60	
Area 26	284,076	4	71,019	4.97%	11,567	2,892	-2.29	
Area 27	308,600	6	51,433	28.90%	27,359	4,560	-1.95	
Area 28	163,359	2	81,680	4.41%	8,613	4,307	-0.72	
Totals	10,794,463	132	81,776		625,148	4,736	-39.39	

* Service Area has at least 120,000 base population per accelerator.

** Area has more than 45% of its patients coming from outside the service areas.

Table 17C-5: Linear Accelerator Service Areas and Calculations

Service Area	2022 Population	Accelerators	Population within Service Area Per Accelerator	Percentage of Patients from Outside the Service Area	2020-2021 ESTV Procedures	Procedures Per Accelerator	ESTV Procedures Divided by 6,750 Minus # of Accelerators	Need Determinations
Area 1	143,240	2	71,620	4.05%	2,699	1,349	-1.60	
Area 2	437,408	8	54,676	25.25%	32,547	4,068	-3.18	
Area 3	98,457	1	98,457	18.49%	2,260	2,260	-0.67	
Area 4	170,143	3	56,714	14.42%	10,193	3,398	-1.49	
Area 5	365,327	6	60,888	9.13%	22,652	3,775	-2.64	
Area 6	486,434	5	97,287	9.85%	33,327	6,665	-0.06	
Area 7	1,423,655	12	118,638	22.19%	79,164	6,597	-0.27	
Area 8	343,520	4	85,880	22.71%	19,652	4,913	-1.09	
Area 9	298,918	4	74,730	26.06%	15,564	3,891	-1.69	
Area 10	660,182	10	66,018	28.05%	53,254	5,325	-2.11	
Area 11*	171,063	1	171,063	9.33%	3,743	3,743	-0.45	
Area 12	643,724	7	91,961	21.48%	41,438	5,920	-0.86	
Area 13*	145,359	1	145,359	12.77%	3,338	3,338	-0.51	
Area 14**	230,595	6	38,433	80.60%	40,297	6,716	-0.03	
Area 15	197,355	2	98,678	15.68%	9,613	4,806	-0.58	
Area 16**	495,501	10	49,550	61.53%	46,277	4,628	-3.14	
Area 17	322,475	3	107,492	23.96%	12,045	4,015	-1.22	
Area 18	532,337	8	66,542	16.59%	25,588	3,198	-4.21	
Area 19	484,598	5	96,920	17.38%	31,848	6,370	-0.28	
Area 20	1,251,139	11	113,740	17.45%	47,861	4,351	-3.91	
Area 21*	136,079	1	136,079		0	0	-1.00	
Area 22**	230,077	2	115,039	46.87%	9,608	4,804	-0.58	
Area 23	215,878	2	107,939	14.36%	14,000	7,000	0.07	
Area 24	187,930	4	46,983	17.73%	16,861	4,215	-1.50	
Area 25*	208,825	1	208,825	14.88%	4,559	4,559	-0.32	
Area 26	284,789	4	71,197	6.18%	13,382	3,345	-2.02	
Area 27	307,784	6	51,297	29.68%	31,966	5,328	-1.26	
Area 28	158,875	2	79,438	4.43%	8,026	4,013	-0.81	
Totals	10,631,667	131	81,158		631,756	4,823	-37.41	

* Service Area has at least 120,000 base population per accelerator.

** Area has more than 45% of its patients coming from outside the service areas.

Table 17C-5: Linear Accelerator Service Areas and Calculations

Service Area	2021 Population	Accelerators	Population within Service Area Per Accelerator	Percentage of Patients from Outside the Service Area	2019-2020 ESTV Procedures	Procedures Per Accelerator	ESTV Procedures Divided by 6,750 Minus # of Accelerators	Need Determinations
Area 1	146,591	2	73,296	6.78%	4,325	2,163	-1.36	
Area 2	432,198	8	54,025	22.77%	36,320	4,540	-2.62	
Area 3	103,076	1	103,076	15.25%	3,339	3,339	-0.51	
Area 4	176,963	3	58,988	17.00%	10,263	3,421	-1.48	
Area 5	375,970	6	62,662	6.84%	24,622	4,104	-2.35	
Area 6	485,085	5	97,017	8.19%	30,869	6,174	-0.43	
Area 7*	1,403,469	11	127,588	21.31%	76,249	6,932	0.30	1
Area 8	327,913	4	81,978	23.76%	19,320	4,830	-1.14	
Area 9	284,671	4	71,168	26.06%	16,457	4,114	-1.56	
Area 10	666,413	10	66,641	27.81%	54,288	5,429	-1.96	
Area 11*	171,014	1	171,014	10.71%	3,820	3,820	-0.43	
Area 12	631,125	7	90,161	22.16%	44,324	6,332	-0.43	
Area 13*	145,480	1	145,480	5.44%	3,270	3,270	-0.52	
Area 14**	227,027	6	37,838	71.62%	40,380	6,730	-0.02	
Area 15	195,020	2	97,510	15.71%	9,556	4,778	-0.58	
Area 16**	491,941	10	49,194	63.65%	45,027	4,503	-3.33	
Area 17	328,960	3	109,653	25.11%	19,483	6,494	-0.11	
Area 18	562,195	8	70,274	17.64%	29,694	3,712	-3.60	
Area 19	508,461	5	101,692	12.51%	32,530	6,506	-0.18	
Area 20	1,189,588	11	108,144	14.79%	46,285	4,208	-4.14	
Area 21*	138,043	1	138,043	0	0	0	-1	
Area 22	216,670	2	108,335	40.24%	10,269	5,135	-0.48	
Area 23*	243,144	2	121,572	11.13%	11,213	5,606	-0.34	
Area 24	197,469	3	65,823	15.13%	16,520	5,507	-0.55	
Area 25*	211,881	1	211,881	9.83%	5,195	5,195	-0.23	
Area 26	302,378	4	75,595	5.18%	13,188	3,297	-2.05	
Area 27	335,494	6	55,916	33.03%	28,962	4,827	-1.71	
Area 28	160,478	2	80,239	4.32%	7,525	3,763	-0.89	
Totals	10,658,717	129	82,626		643,289	4,987	-34.70	1

* Service Area has at least 120,000 base population per accelerator.

** Area has more than 45% of its patients coming from outside the service areas.

**RADIATION ONCOLOGY
IN
INTEGRATED CANCER MANAGEMENT
REPORT OF THE INTER-SOCIETY COUNCIL
FOR RADIATION ONCOLOGY**

Sponsored by the:

American Association of Physicists in Medicine
American College of Medical Physics
American College of Radiology
American Radium Society
American Society for Therapeutic Radiology and
Oncology
North American Hyperthermia Group
Radiation Research Society
Radiological Society of North America
Society of Chairmen of Academic Radiation Oncology
Programs

DECEMBER 1991

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PRIOR "BLUEBOOKS"

1968 - A Prospect for Radiation Therapy in the United States	
1972 - A Proposal for Integrated Cancer Management in the United States: The Role of Radiation Therapy	
1981 - Criteria for Radiation Oncology in Multidisciplinary Cancer Management	
1986 - Radiation Oncology in Integrated Cancer Management	

SUBCOMMITTEE TO WRITE "RADIATION ONCOLOGY IN INTEGRATED CANCER MANAGEMENT"

Robert G. Parker, M.D. (Chair)
C. Robert Bogardus, M.D.
Gerald E. Hanks, M.D.
Colin G. Orton, Ph.D.
Marvin Rotman, M.D.

INTER-SOCIETY COUNCIL FOR RADIATION ONCOLOGY (ISCRO)

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Alfred R. Smith, Ph.D.	American College of Medical Physics
J. Frank Wilson, M.D.	American Radium Society

August 5, 1991

Gerald Hanks, M.D.
Chairman, Inter-Society Council for Radiation Oncology
Department of Radiation Oncology
Fox Chase Cancer Center
Central and Shelmire Avenues
Philadelphia, PA 19111

Dear Gerry:

The fifth "Blue Book," *Radiation Oncology in Integrated Cancer Management*, has been completed. This document continues an evolution from *A Prospect for Radiation Therapy in the United States* (1968), *A Proposal for Integrated Cancer Management in the United States: The Role of Radiation Oncology* (1972), *Criteria for Radiation Oncology in Multidisciplinary Cancer Management* (1981) and *Radiation Oncology in Integrated Cancer Management* (1986).

The sections on Quality Assurance and Criteria for Utilization of Equipment and Facilities have been extensively revised and a section on Economic Issues has been added.

Members representing the professional societies which comprise the Inter-Society Council for Radiation Oncology support this document.

Sincerely,

Robert G. Parker, M.D., Chair
ISCRO Subcommittee for
Revision of the "Blue Book"

August 5, 1991

Eli Glatstein, M.D.
NCI, Department of Radiation Oncology
Building 10, Room B3-B69
9000 Rockville Pike
Bethesda, MD 20892

Dear Eli:

The Inter-Society Council for Radiation Oncology is a group of radiation oncologists, biologists, and physicists who are organized to foster the development of research, education, and the clinical sciences in the field of radiation oncology. We actively review research proposals and undertake projects with the purpose of improving cancer treatment.

I am pleased to present you with a copy of the final draft of the fifth edition of "Radiation Oncology in Multidisciplinary Cancer Management," commonly known as the "Blue Book."

Traditionally, the Blue Book has received the endorsement of the National Cancer Institute and ISCRO now would welcome your endorsement of the 1991 edition.

As you are aware, the Blue Book is extremely important in the planning and staffing of radiation therapy facilities. Perhaps, most importantly, it has become the back bone of quality assurance programs.

This 1991 edition of the Blue Book has two objectives. Reasonable standards for radiation therapy, inclusive of those for personnel, equipment, facilities and operations, are defined, and guidelines for the optimal use of radiation therapy in the integrated management of patients with cancer are suggested.

Thank you for your consideration of our request and I look forward to hearing from you.

Sincerely,

Gerald E. Hanks, M.D.
Chairman

August 27, 1991

Dr. Gerald E. Hanks
Chairman
Inter-Society Council for Radiation Oncology
1101 Market Street
14th Floor
Philadelphia, PA 19107

Dear Dr. Hanks:

I commend you and ISRO subcommittee members for the 1991 "Blue Book" revision entitled, "Radiation Oncology in Multidisciplinary Cancer Management." This report, the fifth edition prepared by the radiation oncology community, succinctly presents the standards for clinical practice and the objectives for radiation oncology during the remainder of the 1990s. Our evaluation of the criteria for standard radiotherapy practice is particularly important at this time because multi-modality cancer treatment has an increasing number of cancer patients. Your continued effort to provide standards for radiation oncologists as well as guidelines for health care leaders is an excellent example for other oncologic disciplines.

The National Cancer Institute established the Radiation Research program in 1982, and this program continues to provide a visible and strong focus within the NCI for support of research and related activities in radiation oncology, diagnosis, biology, and physics. Your activities represent an important complement to the research initiatives sponsored by the NCI program.

I am pleased to endorse the 1991 report and once again encourage you and your colleagues in the radiation oncology community to continue your efforts in the conquest of cancer.

Sincerely,

Eli Glatstein, M.D., Acting Director
Radiation Research Program
National Cancer Institute

August 12, 1991

Gerald Hanks, M.D.
Chairman, Inter-Society Council for Radiation Oncology
Department of Radiation Oncology
Fox Chase Cancer Center
Central and Shelmire Avenues
Philadelphia, PA 19111

Dear Dr. Hanks:

On behalf of the Commission on Radiation Oncology of the American College of Radiology, I wish to commend you and your colleagues for the work you have done in revising the "Blue Book." This fifth edition, "Radiation Oncology in Integrated Cancer Management," builds effectively on the strong foundation established by the previous four versions which, since 1968, have placed radiation oncology in a unique position within cancer management by having established criteria for the proper delivery of radiation therapy. This document will serve, as its predecessors have, to provide the most up-to-date elements of the structure and process for providing the most effective radiation therapy. Personnel and equipment requirements, programs for monitoring the quality of patient care, and descriptions of the key interactions with the patients, are well described. It will serve well the needs of cancer patients and those committed to providing the best care for those patients, throughout the last decade of the 20th Century.

Sincerely,

James D. Cox, M.D., Chairman
Commission on Radiation Oncology
American College of Radiology

I. INTRODUCTION

Every patient with cancer should have access to the best possible care regardless of constraints such as geographic separation from adequate facilities and professional competence, economic restrictions, cultural barriers or methods of health care delivery. Suboptimal care is likely to result in an unfavorable outcome for the patient, at greater expense for the patient and for society.

The major components of treatment continue to be surgery, radiation therapy and systemic chemotherapy. Optimal use of these therapeutic modalities requires proper *initial* management decisions. These decisions must be made by health care professionals, who have an understanding of the biology of cancer in the human and the treatment options.

Potential contributions and liabilities of each treatment method must be presented by surgeons, medical oncologists and radiation oncologists as equal members of the patient management team. Essential pretreatment interaction amongst surgeons, medical oncologists and radiation oncologists should continue throughout the course of treatment and the long-term follow-up for every patient.

Patients with cancer, and/or their selected advisors or relatives, must have the opportunity to become fully informed about their medical status, all of the reasonable treatment options and the likely consequences of each management program and even of no treatment. This right of patients to participate in decisions related to their care must be respected at all times.

There are many different approaches to providing *optimal* care. These are tailored to local needs and resources. However, in every circumstance, the integration of highly trained personnel and expensive facilities is required. High quality radiation therapy can be provided most efficiently when the number of patients is large enough to fully utilize the necessary expertise and expensive facilities. Currently, in the United States, at least 50% of facilities have only one

II. OBJECTIVES OF THIS REPORT

In this report:

- 1) reasonable standards for radiation therapy, inclusive of those for personnel, equipment, facilities and operations, will be defined; and
- 2) guidelines for the optimal use of radiation therapy in the integrated management of patients with cancer will be suggested.

megavoltage radiation treatment unit, and approximately 25% are staffed by a single physician either full-time or part-time¹. It is essential that these limited facilities, whether located in a hospital or free-standing, have the capability for the same high quality patient care available in larger centers. Treatment planning skills, a computer-based treatment planning system, simulation, direct medical radiation physicist involvement, high energy photon and electron beams, skilled brachytherapy and the capability to fabricate treatment aids must be available to the patients in small facilities, either on-site or through arrangements with nearby centers.

Although good radiation therapy programs always have included procedures specifically designed to minimize error and risk and to promote consistent high quality patient care, these activities have become formalized Quality Assurance Programs.

Multiple groups within and outside medical centers now require extensive documentation of compliance with defined standards as a requisite of continued approval of the program and the affiliated medical center.

The costs of health care in general, and for patients with cancer specifically, have come under increased scrutiny. Although the support of radiation therapy in the United States consumes less than 0.5% of health care expenses (Powers, W.E., personal communication, 1989), the expensive facilities and extensively trained personnel are likely targets for cost containment.

Consequently, expanded and updated sections on Quality Assurance and Utilization of Facilities and Equipment are included in this publication.

¹Facility Master List Survey, Patterns of Care Study, American College of Radiology

III. GOALS OF CANCER MANAGEMENT

The primary goal of health care personnel and their supporting organizations, and of society generally, is to provide the best possible care to every patient with cancer. The objectives of cure, palliation or long-term tumor control must be clearly defined. Each patient, whether part of an organized study or not, must become a source of information available for continual improvement of therapeutic performance. Concurrently, better methods, equipment and facilities must be developed, and educational programs must be provided for personnel.

IV. THE CLINICAL ROLE OF RADIATION THERAPY

Surgery, radiation therapy and systemic chemotherapy remain the bases of the management of patients with cancer. Hopefully, other methods, such as those modulating the host's immune system, will soon prove useful, at least as adjuvants.

The usual objective of surgery or radiation therapy is local/regional control of tumor. In addition, ionizing radiations may be used as a systemic agent. Chemotherapy usually is used systemically, although it may, on occasion, be used regionally. Surgery, radiation therapy and chemotherapy can be used individually or in various combinations and sequences.

Currently, radiation therapy is used in the management of 50-60% of all patients with cancer. Its use, as for surgery and chemotherapy, must be decided and controlled by specifically trained, competent personnel.

Radiation therapy may be used alone or with other treatments to cure humans with cancers arising in nearly every anatomic site. The inherent advantage of the method is the preservation of anatomic structures and their function. Today, cure should be the objective for approximately 50% of all patients treated. For these patients, cost, inconvenience and iatrogenic morbidity may be of less concern than they are for those unfortunate patients, who are not curable by currently available methods.

Properly used, radiation therapy is a superb palliative agent with a high likelihood of success and easily controlled or avoided morbidity. Examples are: relief of pain from bony metastases; preservation of skeletal integrity; reduction of intracranial pressure with resultant relief of headaches and neurological dysfunction; restoration of the patency of tumor-compromised lumina (esophageal, bronchial, vascular); and control of tumor-induced bleeding.

Conventional, external beam radiation therapy (teletherapy) usually is delivered in single daily increments for several weeks. Currently, there are ongoing trials of the use of multiple increments daily over the same period (hyperfractionation) or over shorter times (accelerated fractionation). The prolonged period of treatment provides an opportunity for all members of the radiation oncology team to provide support to patients.

Intraoperative radiation therapy, using single increments of X-rays or electron beams directed to targets exposed at surgery, is being investigated. The potential advantage is the physical displacement or protection of normal structures from the radiation beam. Inasmuch as a fractionated high total dose is not possible with this approach, it is used to deliver a large "boost" dose.

Brachytherapy, exploiting a variety of radionuclide sources, is used primarily for cancers arising in the head and neck, breast and pelvis. The advantage of this method is delivery of a dose to a tumor, which is relatively higher than that delivered to adjacent normal tissues. In most instances, such interstitial and intracavitary placement of radioactive sources is an operative procedure requiring an anesthetic for the patient.

Particles, both charged (protons, helium ions, heavy ions) and unchanged (neutrons) are being investigated, both as teletherapy beams and brachytherapy agents. Such particles produce more dense ionization in tissues and so theoretically reduce the adverse influence of cellular hypoxia and the effect of position in the cell cycle at the time of irradiation.

Augmentation of the therapeutic effectiveness of ionizing radiations, through the use of adjuvants, is being investigated. Heat applied regionally may be cytotoxic at 42–45°C, and it may augment cell killing by ionizing radiations or chemotherapeutic agents. Selective effectiveness of heat against cancer cells is based on the diminished blood flow in tumors relative to normal tissue with consequent decreased ability to dissipate heat and maintain normal homeostasis. Several systemically administered drugs may increase the sensitivity

of cells to ionizing radiations. Some of these, such as doxorubicin and dactinomycin, unfortunately, may increase the radiation sensitivity of both tumor and normal cells and, consequently, a therapeutic advantage does not result. Electron-affinic compounds may lessen the adverse effects of tumor cell hypoxia on radiosensitivity.

Total body irradiation, long used in multiple small doses as a therapeutic agent in hematopoietic and lymphomatous disorders, is used in larger doses to destroy abnormal (and normal) bone marrow prior to the transplantation of healthy marrow. Total body irradiation, or total nodal irradiation, is used to suppress the immune system in a variety of diseases.

V. THE PROCESS OF RADIATION THERAPY

The clinical use of ionizing radiations is a complex process involving highly trained personnel in a variety of interrelated activities (Tables V-1A and V-1B).

A critical step is the initial evaluation of the patient and an assessment of the tumor. This requires a pertinent history, complete physical examination, a review of all diagnostic studies and reports and discussion with the referring physician.

The radiation oncologist must be aware of the biologic characteristics of the patient's cancer as a basis for estimating its clinical behavior and planning treatment. The documented extent of each cancer must be recorded as a basis for staging. This will support an estimate of the prognosis for each patient and will enable comparison of treatment performances between different medical centers.

Initial decisions about therapy include: an estimate of whether treatment is likely to help the patient; selection of cure or palliation as the objective; and identification of alternative therapies with consideration of their relative merits. If ionizing radiations are to be used, the team characteristics and/or radionuclide sources, the method and pattern of delivery, doses and sequencing with other treatments must be known.

It is important to discuss these initial tentative decisions with the patient's other physicians, the patient and responsible family members or designees.

Treatment planning requires determination of the tumor site and extent in relation to normal tissues. This assessment is based on physical examination, endoscopy, diagnostic imaging and findings at surgery. The relative contributions of external radiation beams, brachytherapy, intraoperative irradiation and adjuvants need to be considered. The radiation oncologist specifies the doses desired throughout the tumor and sets limits of doses to critical structures. The physician, medical radiation physicist and dosimetrist then

TABLE V-1A
PROCESS OF RADIATION THERAPY (EXTERNAL BEAM)

1. **CLINICAL EVALUATION**
Initial multidisciplinary evaluation of patient
Decision for radiation therapy
Assessment of pathobiology of tumor
Staging
2. **THERAPEUTIC DECISION-MAKING**
Selection of treatment goals—cure/palliation
Choice of modalities of treatment
3. **TARGET VOLUME LOCALIZATION**
Definition of tumor extent and potential routes of spread
Identification of sensitive organs and tissues
4. **TREATMENT PLANNING**
Selection of treatment technique
Computation of dose distribution and verification of accuracy
Determination of dose/time/volume relationship
5. **SIMULATION OF TREATMENT**
Selection of immobilization devices
Radiographic documentation of treatment ports
Measurement of patient
Construction of patient contours
Shaping of fields
6. **FABRICATION OF TREATMENT AIDS**
Construction of custom blocks, compensating filters
7. **TREATMENT**
Initial verification of treatment set-up
Verification of accuracy of repeated treatments
Continual assessment of equipment performance
Periodic checks of dosimetry, record keeping
8. **PATIENT EVALUATION DURING TREATMENT**
Evaluation of tumor response
Assessment of tolerance to treatment
9. **FOLLOW-UP EVALUATION**
Evaluation of tumor control
Assessment of complications of treatment

TABLE V-1B
PROCESS OF RADIATION THERAPY (BRACHYTHERAPY)

1. **CLINICAL EVALUATION**
Initial multidisciplinary evaluation of patient
Decision for radiation therapy
Assessment of pathobiology of tumor
Staging
2. **THERAPEUTIC DECISION-MAKING**
Selection of treatment goals — cure/palliation
Choice of modalities of treatment
3. **TARGET VOLUME LOCALIZATION**
Definition of tumor extent and potential routes of spread
Identification of sensitive organs and tissues
4. **TREATMENT PLANNING**
Selection of volume to be treated
Selection of geometry for application
Computation of doses and dose distributions
Estimation of tolerance to procedure
Check off of equipment
Arrangement for surgical suite and anesthesia
5. **TREATMENT**
Examination of anesthetized patient
Review of initial treatment plan
Implantation
6. **VERIFICATION OF IMPLANTATION**
Orthogonal or stereo radiographs
7. **DOSIMETRY**
Calculation from actual implantation
Establishment of time for removal
8. **PATIENT EVALUATION DURING TREATMENT**
Assessment of tolerance
Check of position of implant
9. **REMOVAL OF IMPLANT**
10. **FOLLOW-UP EVALUATION**
Assessment of early and late sequelae
Evaluation of tumor control

design potential treatment deliveries which satisfy these requirements. The calculation of doses at multiple sites and the mapping of isodose patterns, based on accurately measured doses and other physical characteristics, usually require the use of special computer programs. The physician, upon the advice of the medical radiation physicist and dosimetrist, then selects the best treatment plan for the individual patient.

After the therapeutic approach is selected, the target volume is confirmed and recorded radiographically at simulation. Simulators are specialized units which can reproduce all of the motions of the specific treatment unit to be used. Orthogonal radiographic units are being supplemented by units which display cross-section anatomy. The use of cross-section anatomy (CT scans) supports three-dimensional definition of the target volume. Such use allows immediate treatment planning with later simulation for field marking, identification of treatment unit parameters and radiographic verification of the treatment set-up. The availability of fluoroscopy aids and hastens the process. Simulation, which may be a two-step process, is carried out by a specially trained radiation therapy technologist under the supervision of the radiation oncologist.

Devices to aid in positioning and immobilizing the patient, normal tissue shields, compensating filters and other aids need to be designed and fabricated. This requires access to a specialized preparation room and a machine shop.

Prior to initiation of treatment, radiographs produced by the treatment beam of the teletherapy unit are compared to the simulator films to verify that the beams and targets are identical. Dosimeters may be used, *in vivo*, to measure and record actual doses at specific anatomic sites.

Daily treatments are carried out by radiation therapy technologists who are under the direct supervision of the radiation oncologist and the medical physicist. It is essential that all treatment applications be described in detail (orders) and signed by the responsible physician. Likewise, any changes in the planned treatment by the physician

may require adjustment in immobilization, new calculations and even a new treatment plan. Thus, the technologist, physicist and dosimetrist need to be notified.

Although the daily treatment is set up on the teletherapy unit by technologists, a responsible physician must be available in the department or nearby for confirmation of the treatment, if necessary, and for unscheduled decisions and supervision of personnel. A variety of specific checks to insure conformity to the planned treatment should be in place. Therefore, a physician does not need to visually check each treatment set-up.

The responsible physician monitors the patient's progress by checking the daily entries in the treatment chart and discussing the patient with the technologists, nurses, relatives or friends, and other involved physicians and by periodic examinations. Re-evaluation examinations usually are scheduled at least weekly. Portal verification films, pertinent laboratory and visual imaging studies are periodically ordered and reviewed. The patient, referring physician and responsible friends and/or relatives should be informed of the progress of treatment.

Periodic post-treatment assessment of the accomplishments and possible sequelae of treatment is essential. The radiation oncologist, as the most qualified observer to detect and initiate management of post-irradiation tumor activity or sequelae in normal tissues, must be involved in the post-treatment follow-up program. Early detection of post-treatment tumor activity may permit additional treatment, which may be curative. Early detection and treatment of radiation-induced sequelae may avoid serious problems later.

VI. QUALITY ASSURANCE OF RADIATION THERAPY

The purpose of a Quality Assurance Program is the objective, systematic monitoring of the quality and appropriateness of patient care. Such a program is essential for all activities in Radiation Oncology.

The Quality Assurance Program should be related to structure, process and outcome, all of which can be measured. Structure includes the staff, equipment and facility. Process covers the pre- and post-treatment evaluations and the actual treatment application. Outcome is documented by the frequency of accomplishing stated objectives, usually tumor control, and by the frequency and seriousness of treatment induced sequelae.

The Director of Radiation Oncology is responsible for the organization and supervision of the departmental Quality Assurance Program.

Periodic (at least monthly) audits of recently completed charts by designated reviewers using appropriate screens (check lists) should be reported to the departmental Quality Assurance Committee. All identified problems should be discussed and recorded and a remedial action plan instituted. Requirements of the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) and the Nuclear Regulatory Commission (NRC) should be fulfilled.

Components of a Quality Assurance Program for Radiation Oncology are summarized in the following:

6.1 Equipment

Minimal requirements for equipment include: 1) at least one supervoltage/ megavoltage teletherapy unit, with an energy exceeding 1 MV. The distance from the source to the isocenter must be at least 80 cm; 2) access to an electron beam source or a low energy X-

ity unit; 3) appropriate brachytherapy equipment and sources for intracavitary and interstitial treatment; 4) adequate equipment to calibrate and measure dosimetric characteristics of all treatment units in the department; 5) capability to provide appropriate dose distribution information for external beam treatment and brachytherapy; 6) equipment for accurate simulation of the treatment units in the department; 7) field-shaping capability; and 8) access to CT scanning capability (advisable).

2 Programs

Minimal programs include: 1) calibration of equipment and measurement of radiation beam characteristics to assure accurate and reliable delivery of the ionizing radiations; 2) charting systems for recording treatment doses; 3) accurate calculation of doses and dose distributions, checks of dose calculations and ongoing reviews of accumulating doses; 4) devices for prevention of mechanical injury of the patients or personnel by the treatment units or accessory equipment; 5) surveillance of the wearing, reading and recording of information from individual film badges; 6) systematic inspection of interlocks; 7) routine leak testing of sealed radioactive sources; 8) availability of safety equipment and use of personnel and patient safety procedures when fluoroscopy and sealed radioactive sources are used; 9) instruction in safe work habits and pertinent new developments; and 10) regular maintenance and repair of equipment.

5.3 Facilities

It is necessary that ramps, doorways, halls and lavatories accommodate wheel chairs, walkers and litters (except for lavatories). There should be holding areas for patients on litters or in beds. The internal environment should provide adequate lighting, ventilation and temperature control. Emergency procedures for fires and other catastrophes should be in place and understood by personnel.

6.4 Patient Evaluation and Treatment

All components of the evaluation of the patient and his/her cancer must be documented in the patient's Radiation Oncology Record. The format, which should facilitate care of the patient in the department, usually includes: a general information sheet listing the names of pertinent relatives, follow-up contacts, referring and family physicians and persons to notify in an emergency; initial history and findings on physical examination; reports of the pathology examinations, laboratory tests, diagnostic imaging studies and pertinent operations; photographs and anatomic drawings; medications currently used; correspondence with physicians and reimbursement organizations; treatment set-up instructions; daily treatment logs; physics, treatment planning and dosimetry data; progress notes during treatment; summaries of treatment; and reports of follow-up examinations.

It is essential that these radiation oncology records be maintained and secured in the department separate from hospital and clinic records to insure ready access at any time for a variety of purposes. Lack of immediate access to patient data can disrupt daily activities in the radiation oncology department. For example, all current and previous treatment data and the treatment plan, with any recent changes, must be available to the radiation therapy technologists each day when the patient is set up for treatment, before the beam is activated. Inasmuch as patients may be treated every 10-15 minutes throughout the day on each megavoltage unit, lack of immediate availability of data on a specific patient would result in chaos. In addition, radiation oncologists, who are on-site and thus "available", frequently receive unscheduled inquiries about patients being treated or those whom have been treated. Copies of pertinent data generated in the department, such as the initial consultation report, the summary of treatment and reports of follow-up visits must be included in each patient's hospital chart to be available to others throughout the medical center.

Informed Patient Consent

Prior to the initiation of any patient management program, the patient must give valid consent for the actual treatment and related activities such as photography of the face or treatment portals. If the patient is not mentally competent, consent must be obtained from a legally qualified representative. Each radiation oncology center should have a methodology to explain to the patient, or proper representatives, the patient's status, treatment alternatives with their reasonable objectives and possible sequelae and the consequences of treatment. Informational materials, such as brochures, tape recordings, video presentations and identification of available support services, may help the patient to understand and consequently to comply. If possible, explanations should be in the language preferred and best understood by the patient.

5 Treatment Planning Data

All data used in planning the specific treatment for a patient could be immediately available for review. These include: anatomic drawings, copies of appropriate visual imaging examinations, radiotherapy plans, simulation of treatment, computation of beams and dose patterns, reasons for the choice of a specific management program, treatment beam verification films, calculation of doses and dose distributions and records of special physical measurements.

7 Treatment Data

The centerpiece of the patient's radiation therapy record is the charting of each treatment. These entries, which must be made at the time of each application of ionizing radiations, usually include the daily and cumulative doses through each field to the target and sites of special interest, such as the spinal cord, kidney or eye. For regular-shaped fields, doses should be calculated at several anatomic sites. Supporting data, such as the actual identifying number and dimensions of each field, maximum dose to each field, consecu-

tive number of the treatment, overall time since initiation of treatment and actual date, usually accompany the dose entries. In addition, there should be positive identification of the equipment used, any treatment aids, the responsible radiation oncologist and referring physician. A written prescription, signed by the responsible radiation oncologist, should include daily and total doses to a specific site (stated depth or isodose contour) in a definite overall time, number of fields to be treated daily and the pattern of application (number of treatments per week). Photographic recording of the position of the patient during treatment, each treatment field and the patient's face help recall.

6.8 Assessment of Treatment

The results of treatment, with documentation of the status of the tumor and sequelae, must be assessed for every patient. Periodic evaluation of patients, in concert with other physicians including oncologists and the primary care provider, is an essential part of management. This is a responsibility shared by the patients and their physicians. A record of outcome by anatomic site, stage and histology should include all patients treated. Other information such as the presence of intercurrent diseases and other treatments is useful. Documenting and keeping these records current is necessary to insure high quality performance. This ever increasing burden of monitoring results should be simplified through the use of an automated data retrieval system.

6.9 Patient-Related Data

The following data should be maintained and kept current at every treatment facility: number of new and former patients seen in consultation; number of new and former patients treated; number of tumors treated at each anatomic site; number of simulations; number of treatment plans; number of treatment portals; whether the treatments were simple, complex or intermediate; number and types of brachytherapy procedures (interstitial implantations, intracavitary

nsertions, surface and special applications); and number of post-treatment follow-up examinations.

Annual summaries of these data should be analyzed.

5.10 Assessment of Operations

Each facility should have ongoing programs to monitor operations. Patient flow parameters, such as access to parking, promptness of patient scheduling, intervals from referral to consultation and initiation of treatment, patient treatment throughput per unit time, must be assessed so that deficiencies can be corrected.

5.11 Medical Radiation Physics

The ultimate objective of Medical Radiation Physics activities is to assure the delivery of high quality radiation therapy. These activities include active participation in: treatment planning; consultation and educational activities aiding the radiation oncologists and other staff; decisions on the purchase of equipment; and activities that assure that all radiation equipment and sources are operated and handled safely in order to provide adequate protection of staff, patients and the general public.

The Quality Assurance Program in Medical Radiation Physics must be developed and monitored by a qualified medical radiation physicist. Necessary quality control of the physical components of radiation therapy includes: 1) assurance of proper, accurate and safe function of all treatment units and simulators; 2) procurement and storage of radioactive sources, and monitoring the proper function of brachytherapy applicators; 3) treatment planning with computer support; 4) monitoring of dosimetry, calibration and beam characteristics; and 5) surveillance safety of patients and personnel. These activities are outlined in Tables VI-1 to VI-4.

The success of radiation therapy is dependent on the accuracy of delivery of specified doses to selected targets, both in tumors and

normal tissues. The margin for prevention of serious error may be slight. Therefore, the Medical Radiation Physicist must be provided with adequate personnel and equipment to accomplish these important tasks.

TABLE VI-1
Quality Assurance: Treatment Machines and Simulators

1. RADIATION SURVEY

2. MECHANICAL SPECS. AND ALIGNMENT

- a. mechanical isocenter
- b. light field (5x5 cm, 10x10 cm, 30x30 cm)
- c. collimator rotational and cross hairs alignment
- d. patient support assembly — 1/rotational
2/vertical
3/horizontal
4/lateral
- e. gantry rotation range and speed
- f. gantry rotation alignment
- g. laser localizer alignment

3. RADIATION ISOCENTER

- a. alignment of collimator rotational axis
- b. radiation beam and axis of gantry rotation
- c. light field and radiation field coincidence
- d. distance indicator

4. X-RAY BEAM PERFORMANCE

- a. field flatness
- b. field symmetry
- c. photon beam symmetry vs. gantry angle
- d. photon beam energy
- e. dosimetry reproducibility and linearity
- f. arc therapy

5. ELECTRON BEAM PERFORMANCE

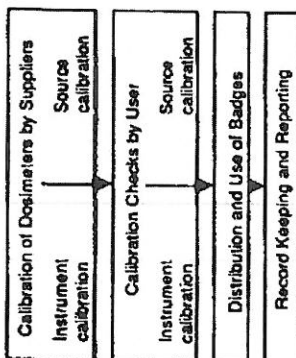
- a. electron beam flatness
- b. electron beam symmetry
- c. electron field symmetry vs. gantry angle
- d. depth ionization
- e. X-ray contamination
- f. dosimetry reproducibility and linearity

TABLE VI-2
QUALITY ASSURANCE: TREATMENT PLANNING

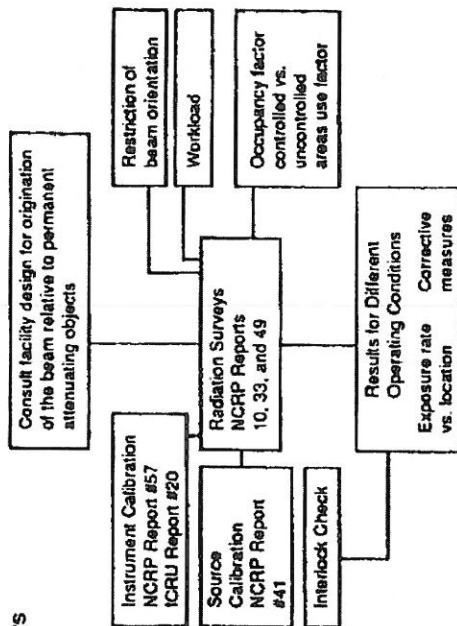
DIAGNOSTIC PATIENT DATA ACQUISITION	Quality Assurance Action	
	Diagnostic X-ray Nuclear Medicine, Ultrasound	Image quality assurance procedures are established in Diagnostic Departments.
	CT, MRI	Special procedures relating to therapy.
	Simulator	Image quality and mechanical integrity.
TREATMENT DECISION, TUMOR LOCALIZATION	Data synthesis, Contours Delineation of target volume and sensitive organs	Clinical quality assurance. Accuracy of contouring equipment. Simulator quality assurance
COMPUTATION OF DOSE AND DOSE DISTRIBUTION	TAR and/or other dose concepts, Algorithms Computer Fieldshaping Independent checks of calculations	Data verification for individual machines. Accuracy of calculational methods. Input-output devices of computer. Documentation of dose distribution data and calculational procedures.
IMMOBILIZATION BLOCKS AND WEDGES	Immobilization Devices, Mould Materials and Block Cutters	Frequent alignment and stability checks. Personnel safety in regard to material toxicity (lead, cadmium, tin, etc.) and shop procedures. Patient Safety.
TREATMENT VERIFICATION	Port film Verification	Field delineation and adequacy of tumor coverage (physicians should sign films). Image quality.
	Patient Charts - Routine checks	Dose summations and treatment prescriptions.
	Equipment Log Books	Adequate calibration records. Machine problems and performance.
	Patient Dosimetry	Dosimetry and equipment verifica- tion. Dosimeter placement. Analysis and reporting of results.

TABLE VI-4
QUALITY ASSURANCE: RADIATION SAFETY

PERSONNEL
DOSIMETRY



RADIATION SURVEYS



RADIOACTIVE
SOURCE HANDLING

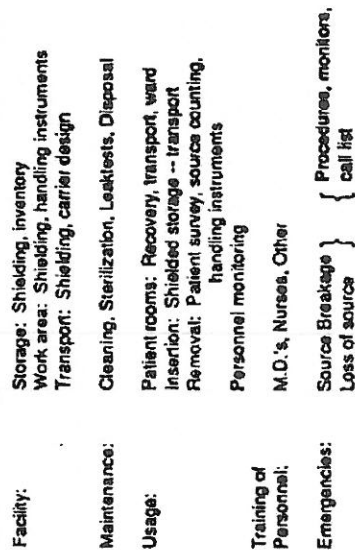


TABLE VI-3
QUALITY ASSURANCE: DOSIMETRY

iodic Calibration
dosimeters

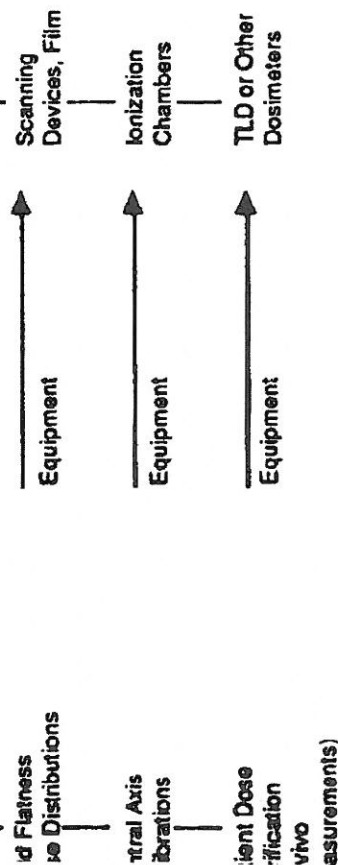


Intercomparisons between Institutions

thytherapy Source Calibrations

eration of Beam Data
When Commissioning Equipment
After Major Repairs
Periodically

iodic Constancy Checks of:



VII. CRITERIA FOR UTILIZATION OF EQUIPMENT AND FACILITIES

An analysis of utilization of radiation therapy is the usual basis for documenting the need for additional, new or upgraded facilities and equipment and additional or different personnel. This is a complex process which may be influenced by departmental, institutional, regional, economical and political considerations.

1. General Guidelines

Appropriate numerical guidelines relate the numbers and types of patients managed, the complexity of treatments, personnel, equipment and facilities. These guidelines may be modified by variations between radiation oncologists and between treatment centers, accessibility of radiation therapy facilities to patients, limitations of existing equipment, transferability of patients between treatment facilities and financial agreements between medical centers. Such guidelines may change in time as technology and practice evolve.

2. Guidelines for Equipment Utilization

- A realistic load for a megavoltage unit is about 6,500 standard treatments (equivalent simple treatment visits or ESTVs)* per year. This approximation is based upon an average of four patients treated hourly for 7 hours daily, 5 days per week, 51 weeks per year with allowances for double time for initial set-ups of five patients starting treatment per week, for verification films and other checks once weekly on 50% of patients being treated and for equipment maintenance or repair one day per month.

*Equivalent Simple Treatment Visit (ESTV)—The time required, usually about 15 minutes, for a uncomplicated set-up and treatment of a patient on a modern megavoltage unit.

This can be calculated as follows:

4 standard treatments/hr x 7 hr/day x 5 days/wk	
x 51 wks/year	= 7,140
less double time for initial treatment	
of 5 patients/week	= 260
less one day per month down time for equipment	
maintenance and repair (28 patients x 12 days)	= 336
patient treatments per year per unit	= 6,544

The 7-hour-daily patient treatment schedule allows for equipment quality assurance procedures, warm-up time for a linear accelerator, room preparation and clean-up, and other support activities, which in total with actual treatment comprise an 8-hour work day.

As the proportion of patients requiring multiple treatments per day (hyperfractionation) or complicated treatment techniques, such as total body irradiation, total nodal irradiation or irradiation while bedfast or anesthetized increases, the number of patients treated per unit time and the total number of treatments on each apparatus will decrease. Thus, at many major referral and university medical centers, the number of treatments per megavoltage unit may be closer to 5,000 per year.

- If it is assumed that approximately 50% of patients will be treated for cure (30–40 increments) and 50% for palliation (10–20 increments), then about 250 patients can be treated on each megavoltage unit annually.

Patients treated for cure:

$$125 \text{ patients} \times 35 \text{ Rx (average)} = 4,375$$

Patients treated for palliation:

$$125 \text{ patients} \times 15 \text{ Rx (average)} = 1,875$$

Total

$$6,250$$

However, if the ratio changed to 60% of patients treated for cure and 40% treated for palliation, only 200 patients could be treated per megavoltage unit annually. Therefore, the percentage of patients treated for cure at a given institution is a major determinant in the capacity of each treatment unit.

A treated patient refers to a single course of treatment for a specific disease. If a patient returns for additional courses of treatment for new problems related to the initial cancer or to a different cancer, this is considered an additional work unit (number of patients treated). Inasmuch as the effort per patient varies widely, it may be of value to subclassify the patients by the complexity of treatment. (See Section 7.2 d.)

c. One megavoltage radiation therapy unit should serve a population of approximately 120,000 people. This is based on the assumption that 4.1 newly diagnosed cancers will be detected per year per 1,000 people. This frequency should be adjusted for regional factors. For example, in one state the reported frequency of newly diagnosed cancers has been 4.9 per 1,000, while in another it has been 1.9 per 1,000. If 50% of all patients with cancer receive radiation therapy, then a population of 120,000, which will produce about 492 newly diagnosed cancers at 4.1 per 1,000, will provide about 245-250 patients with cancers who will receive radiation therapy.

d. Adjustments to the above criteria must be made for: 1) dedicated special- purpose treatment units, such as for particle radiation therapy; 2) specialized procedures of limited but important application, such as total body irradiation (TBI), stereotaxic radiosurgery and intraoperative radiation therapy; and 3) patients who are difficult to handle such as infants and those in beds.

Allowances for the complexity of treatment can be based on current CPT-4 data. Simple, intermediate and complex radiation treatments are defined as follows:

Simple – single treatment site, single treatment field or parallel opposed fields with no more than simple blocks;

Intermediate – two separate treatment sites, three or more fields to a single treatment site, use of special blocking;

Complex – three or more treatment sites, tangential fields with wedges, rotational or arc techniques or other special arrangements, complex blocking (i.e., mantle and inverted Y fields).

The basic unit, one Equivalent Simple Treatment Visit (1 ESTV), requires up to 15 minutes on a modern megavoltage teletherapy unit. This includes time for portal filming. An Intermediate Treatment Visit can equal 1.1 ESTVs and most Complex Treatment Visits can equal 1.25 ESTVs.

Special consideration is required for patients needing more time than usual and for use of highly specialized treatment techniques. Thus, for children under 5 years of age, the ESTV can be multiplied by 2, and for most patients in beds the ESTV can be multiplied by 1.2.

For the increased time required for special techniques, supplemental ESTVs can be added for each visit:

Total body irradiation (photons or electrons)....	Add 4.0 ESTVs
Hemi-body irradiation	Add 2.0 ESTVs
Intraoperative radiation therapy	Add 10.0 ESTVs
Particle radiation therapy	Add 2.0 ESTVs
Dynamic conformational radiation therapy with moving gantry, collimators and couch	Add 1.5 ESTVs
Limb salvage irradiation at lengthened SSD	Add 1.0 ESTV
Additional field check radiographs	Add 0.5 ESTV
Stereotaxic radiosurgery	Add 3.0 ESTVs

e. Types of Equipment Required

Patients treated in facilities, which are utilized for curative treatment, should have access to at least two megavoltage units, either in-site or through working agreements. One of these megavoltage units should provide photons of low energy (^{60}Co or 1–6 MV X-rays) and the other, photons, of at least 10 MV and electron energies to at least 12 MeV. Alternatively, a dual-modality, dual-energy accelerator might be sufficient if the lower X-ray energy is 4–6 MV and the highest electron energy is at least 12 MeV. In larger facilities, there should be at least one high energy (10 MV or above) unit to every 2 or 3 lower energy (Co-60 teletherapy, 4–6 MV linear accelerator) units depending on work load, types of patients and tumors treated and availability of expertise and supporting resources.

The increasing use of high energy electron beams as a component of treatment, such as for "boosting" the excision site in the intact breast, reducing the dose to the heart when treating the internal mammary nodes, irradiating the chest wall following mastectomy, treating posterior cervical nodes over the spinal cord or "boosting" the dose to intraoral and pharyngeal tumor sites, requires access to this capability in each facility where curative treatment is attempted. It is unreasonable, and possibly dangerous, to transfer patients between unrelated facilities in order to provide access to electron beam therapy because the necessary coordination of the several components of radiation therapy of a specific patient becomes unlikely. It is unrealistic to assume that all patients needing electron beam therapy will be specifically referred to an "outside" facility for that purpose. For the same reason, brachytherapy must be available so that all components of a patient's treatment can be integrated by the responsible radiation oncologist. Transfer of a patient from one facility to another during a course of radiation therapy is ill-considered because the chances for error and mismanagement are increased. Also, such disruption of care increases the cost to the patient because of duplication of effort, such as resimulation, additional reviews of records and creation of new records. In order to reduce the need to transfer patients or the temptation to treat patients with a less-than-optimal modality, the

purchase of a dual-energy, dual-modality treatment unit should be considered. Despite the above concerns, in rare cases it may still be necessary to provide part of a patient's treatment at a remote facility, where expensive special-purpose treatment equipment is available.

Dislocation of a patient from an organized continuum of care for other reasons, such as an arbitrary geographical or institutional distribution of equipment, should be resisted by both patient and physician. In the past, the use of ill-conceived formulas to geographically distribute facilities and radiation treatment units fostered mediocrity at the expense of programs successful because of high quality performance. Referral of patients to facilities demonstrating high quality service should be supported. Administrative allocation of patients to facilities because they are under utilized promotes neither good care nor cost effectiveness.

f. Efficient Use of Resources

The high cost of an adequate radiation oncology facility generates interest in efficient use. One possibility is operation for more than a single standard work shift. Such an extension of the current conventional period of operation can be supported only if the quality of patient care is uniform throughout the entire work period. This implies comparable availability to all patients of personnel, including physicians, medical radiation physicists, nurses, technologists, receptionists and other support staff and of all services throughout the medical center, including patient billing, laboratories and administrative support. It must be realized, however, that any cost savings are likely to be less than apparent, since the equipment will wear out more rapidly and need to be replaced sooner.

7.3 Criteria for Equipment Replacement

Radiation treatment units require replacement when they become technologically obsolete or worn out. The average life of a modern megavoltage unit (linear accelerator, Co teletherapy unit) has

en 8-12 years if: the equipment has been properly maintained; placement parts have been readily and economically available; and e operational characteristics and mechanical integrity have met performance and safety standards.

Beyond its useful working life, a megavoltage therapy unit eds to be withdrawn from clinical service unless it can be upgraded warranty status and is not technologically obsolete. This periodic placement and renovation of equipment is necessary not only for ality care, but for patient and personnel safety and efficient economic operation. Equipment replacement must be justified on apartmental and institutional, not geographical or political, needs.

4 Criteria for Additional Equipment

The need for additional radiation therapy equipment in a xecific facility should be based upon an increasing number of atients requiring treatment, the changing complexity of treatment or dition of a new specialized service.

Additional megavoltage equipment needs to be considered then:

1. utilization consistently exceeds the level of patient service defined in Section 7.2 (250 new patients treated or 6,500 equivalent simple treatment visits (ESTVs) annually per megavoltage unit);
2. the patient characteristics or tumor types require an increased complexity of treatment, i.e., electron beam "boosts" in breast conservation programs;
3. new techniques requiring more time per patient, i.e., total nodal or whole body irradiation, intraoperative irradiation and multifractionation of the usual daily dose increments, are introduced; and
4. there is an increased commitment to clinical research and teaching.

7.5 Simulators

- a. All modern radiation therapy facilities should have access to at least one simulator, regardless of the number of patients being treated. The need for more than one simulator in a facility can be estimated from the following:

If a simulation, which requires about 60 minutes for an ambulatory, cooperative patient, is designated as an Equivalent Simple Simulation Visit (1 ESSV), the relative values of other simulation procedures can be allocated as follows:

Mantle field	Add 0.5 ESSV
Limb salvage techniques	Add 0.5 ESSV
Intact breast techniques with 3 fields	Add 0.5 ESSV
Extended fields at increased SSD	Add 0.5 ESSV
Conformal techniques for each set-up in excess of 3 fields	Add 0.3 ESSV
for dynamic motion (collimator, gantry, couch)	Add 1.0 ESSV

In general, one simulator can service 2-3 megavoltage treatment units.

- b. Simulators, like megavoltage treatment units, need to be replaced or renovated when they become technologically obsolete, worn out, unsafe or inaccurate. Currently, simulators based on cross-section anatomy, rather than conventional orthogonal projections, are proving very useful and may become an important component of simulation.

7.6 Dedicated Special-Purpose Units

Recent development of sophisticated treatment delivery and planning systems have required the availability of special-purpose

ipment. For example, three-dimensional treatment planning and simulation require direct access to CT units.

Certain treatment capabilities are not needed in every radiation therapy facility but should be available to all patients. Such units, which can be considered regional and sometimes national resources, could be considered separately when assessing equipment and personnel requirements.

Examples are heavy particle accelerators, intraoperative radiation therapy units, stereotaxic radiation devices and special hyperthermia equipment.

Inasmuch as the proper clinical use of these technologies is uncertain, equipment and personnel needs have not been determined.

VIII. Characteristics of Clinical Programs

To enable the best possible management, patients must have convenient access to radiation oncologists and facilities where there are an adequate complement of qualified personnel and state-of-the-art equipment. Decisions about the care of patients should be based on clinical need and not compromised by the lack of immediately available resources.

To provide adequate management of patients, radiation oncology programs may include more than a single facility, several physicians and physicists and a range of skilled personnel. Necessary cooperation between personnel at separate facilities may be based on formal or informal relationships.

8.1 Program Structure

The structure of any radiation oncology program is based on a complex interaction of factors such as: needs of the patient population; demographic characteristics of the regional population; geographic relationships; scientific, educational and service needs; and community and special interests. A single type of organization will not function optimally in all situations; therefore, alternatives are necessary.

Possible structures include:

- 1) independent, self-contained centers;
- 2) conjoint centers with affiliated units of varying autonomy contributing to the overall function; and
- 3) regional networks of units organized for special purposes such as clinical research and education.

8.2 Personnel

The most important component of any program is the personnel. Requirements for various skills will vary with requirements for

tient service, education programs, research and community interests. (See definitions in Glossary XI).

2.1 Guidelines for Patient Service

Guidelines for minimum personnel necessary for good patient care are listed in Tables VII-1 and VIII-2. Personnel requirements may vary somewhat related to specific needs of the treatment program.

2.2 Guidelines for Academic Programs

In addition to personnel for patient management, academic programs have additional needs commensurate with requirements for teaching, research and development of advanced technology. For example, a full-time academic radiation oncologist may have less than a 50% time commitment to patient management. Therefore, the ratio of physicians to patients treated would become one for 125 patients irradiated annually. Similar academic commitments increase the number of physicists required. For teaching, research, technology development and ever increasing quality assurance responsibilities, the complement of physicists could easily be at least double the numbers listed in Table VII-1.

In addition, administrative requirements further reduce the ratio of physicians and physicists to patients treated.

Research and education activities need to be financially supported by means other than direct patient revenues. However, many of the administrative activities relate to patient care, particularly as outside regulatory and reimbursement agencies become involved.

Personnel, other than physicians, physicists, radiation therapy technologists, nurses and dosimetrists, required for the effective operation of a radiation oncology clinic include: an administrator; specially trained secretaries; medically trained transcriptionists; a receptionist; special duty clerks; an orderly; financial and personnel supervisors; a maintenance engineer and/or electronics technician;

block/mold room technologist; a data manager; a dedicated social worker; and a dietitian. Personnel capable of maintaining complex radiation therapy units, such as linear accelerators and simulators, and physics equipment, must have skills usually not found in general biomedical electronics groups. Therefore, these people need to be specifically recruited and assigned to the radiation oncology facility. Programs with 2 or more megavoltage accelerators may require dedicated maintenance personnel.

8.3 Equipment

8.3.1. External Beam Treatment Units

A variety of equipment produces beams of ionizing radiations for therapy. These sources are electronic and radioisotopic. Their characteristics are summarized in Table VIII-3.

Superficial and orthovoltage X-ray therapy units are used to treat primary and secondary tumors on or near the body surface. These include cancers of the skin, eyelid, oral mucosa (per oral application through a cone) and uterine cervix (transvaginal application through a cone). The desired characteristic is maximal dose distribution on the surface with rapid fall off of dose with increasing depth in underlying tissue. For these reasons (lack of skin sparing and rapid fall off of dose), these X-rays are not suitable for treating deep seated tumors.

Accelerators (linear accelerators and microtrons) of varying energies and configurations have different clinical uses. All modern accelerators should be functionally reliable with an X-ray source that is isocentrically movable about a patient and should have an output adequate for treatment with the source at a distance of 80-100 cm from the patient. Low energy accelerators produce 4-6 MV photons, but usually do not have electron beam treatment capability. They have uses similar to those of ⁶⁰Co teletherapy units. High energy accelerators produce photons above 10 MV and usually have the

capacity to produce a range of therapeutically useful electron beams. Some of these high energy accelerators also have a second photon beam of lower energy (dual-energy unit), thus increasing the versatility of the equipment. This is particularly useful in small facilities with 1-2 megavoltage units. As noted previously, large clinics may have one high energy accelerator for every 2-3 low energy units. This distribution may be more cost effective than using only dual-energy accelerators. However, if electron beams are frequently used, it is advisable to have access to at least two sources in case of equipment breakdown.

Medical betatrons provide high energy photon and electron beams. Although these generators are reliable, low dose output, limited field size and cumbersome motions of the treatment head limit the number of patients treated daily. These units are no longer manufactured.

Microtrons are electric generators similar in principle to linear accelerators but with magnetic bending of the electron paths into circular orbits. The microwave power source is either a klystron or a magnetron. The beam transport system is relatively simple. A single microtron may supply beams to several treatment rooms. Although the first clinical microtron was described in 1972, few have been used.

Cobalt-60 teletherapy units generate photons from the decay of a radioactive isotope. A modern isotope source, with a diameter of 2.0 cm or less, can produce an output of more than 150 cGy per minute at a source to axis distance (SAD) of 80 cm, the *minimum* acceptable distance for clinical teletherapy. The artificially activated ^{60}Co source, which has a half-life of 5.3 years, requires periodic (usually about every 4 years) replacement in a busy clinic.

Teletherapy has been attempted with Cesium-137 sources. Because of the low specific activity of this isotope, the sources often have been larger than 2.0 cm in diameter, leading to an unacceptable beam penumbra. The source-to-patient distance often has been reduced to less than 80 cm in order to increase the radiation output at the site of interest. For these reasons, Cesium-137 teletherapy is *not* acceptable for modern clinical radiation therapy.

It is important that Cesium-137 teletherapy units, Cobalt-60 teletherapy units designed for use at less than 80 cm SAD, old betatrons and other electronic units, i.e., van de Graaf generators, unsuitable for modern clinical use, *not* be counted in any regional clinical radiation therapy equipment survey.

8.3.2 Simulators

Any program in which curative radiation therapy is offered must have access to a modern simulator capable of precisely reproducing the geometric relationships of the treatment equipment to a patient. This simulator must produce high quality diagnostic radiographs. The availability of fluoroscopy increases the usefulness and the patient throughput. Use of fluoroscopy requires special personnel training and careful use because of the radiation hazards. Photon beams of megavoltage therapy units are unsuitable for good quality imaging of anatomic structures within the treatment volume and so do not adequately substitute for a simulator. If there are additional simulators in a department, these may be adequate with only the radiographic, and not the fluoroscopic, capability.

Computerized tomography and magnetic resonance imaging are being used increasingly in radiation treatment planning. If there are no dedicated scanners in the radiation oncology department, it is essential that there be a definite time allotment on the CT and MR scanners in the medical center or clinic to facilitate treatment planning. In a large department, such time requirements become the equivalent of a dedicated imaging unit.

8.3.3 Treatment Planning/Dose Computation Equipment

The calculation of doses at points within the irradiated volume of the patient is an integral part of the delivery of radiation treatments. Curative treatments require careful planning, including an evaluation of several alternate treatment approaches. Thus, it is essential that all radiation therapy facilities have access to modern computerized treatment planning systems. While for small facilities (i.e., < 300

patients/year) it might be adequate to subscribe to a time-sharing system located in a large medical center, having a dedicated system within the department has proven very valuable for providing high quality care. A computerized treatment planning system should, as a minimum, provide the capability of simulation of multiple external beams, display isodose distributions in more than one plane and perform dose calculations for brachytherapy implants. It is highly desirable that the system has the capability of performing CT based treatment planning.

4 Support Services

Radiation oncology is a clinical service which, to be effective, must be a full participant in cancer activities in the medical center or in a private office complex.

4.1 Hospitalization of Patients

Although about 85-90% of patients treated daily in a radiation oncology facility are outpatients, more than 10-15% require hospitalization at some time for a variety of reasons. Many must be in the hospital while implanted radioactive material is in place, because of both public safety concerns and the need for close medical observation and provision of relief of symptoms. Others are hospitalized because of the adverse effects of treatment or the tumor itself. Occasionally, a concurrent illness forces hospitalization. When hospitalization becomes necessary during or after radiation therapy, the radiation oncologist may be the admitting and attending physician, supervising the medical aspects of inpatient care and involving consultants as necessary. In this capacity, the radiation oncologist serves in the same role, and should meet the same standards, as any other admitting/attending physician. This requires admitting privileges and hospital staff membership.

8.4.2 Access to Operating Room

The radiation oncologist must have access to the operating room for a range of brachytherapy procedures. The radioactive materials for interstitial or intracavitary applications need to be placed in appropriate applicators either by or under the direct supervision of radiation oncologists and medical radiation physicists. Inasmuch as this preparation usually is done in a special room in the radiation oncology department, safe transport of the radioactive materials to and from the operating room or patient's room also is their responsibility. Inasmuch as radiation oncologists are responsible for patient selection, applicator selection and preparation and results and sequelae of brachytherapy, it is essential that they participate in each procedure.

8.4.3 Hospitalization of Patients During Brachytherapy

During hospitalization for brachytherapy, patients must be under the control of the responsible radiation oncologist. Procedures, which might alter the position of the applicators, and medications and diet, which may influence the patient's tolerance to the procedure, must be closely controlled and monitored. Patient and personnel radiation safety measures must be firmly established, controlled and monitored by the responsible radiation oncologist, the medical radiation physicist and the radiation protection organization of the medical center.

8.4.4 Clinical Facilities

The clinical facility must be designed to accommodate a large number of outpatients and a limited number of inpatients, many of whom are in hospital beds or wheelchairs. Inasmuch as 85-90% of the patients are outpatients, who may have appointments 5 days per week for several weeks during treatment, it is important that the clinical radiation oncology facility be close to a parking area.

Reception and waiting areas may be designed to separately accommodate the patients being treated and the patients scheduled for consultation and follow-up examination.

An adequate number of examination rooms must be equipped for complete physical examinations, to include the head and neck and female pelvis.

It is useful to have a comfortable room where the physician may discuss the findings and the proposed management program with the patient and relatives.

A physician's work room, adjacent to the clinic examination rooms, allows review of charts and visual aids, discussion, dictation and phone use outside the immediate range of the patients.

A securable medication room for small quantities of narcotics may be useful.

A procedure room for the biopsy of a surface lesion, endoscopy, thoracentesis, and even intracavitary placement of applicators or interstitial sources of radioactive isotopes, extends the range of activities in the department.

The treatment planning area should be near the treatment rooms to promote necessary interchange between the physicians, physicists, technologists and dosimetrists.

A physics laboratory to support dosimetry and equipment calibration needs to be near the treatment units.

Access to a machine shop, for fabrication of unique items of equipment, and to an electronics shop, for maintenance of electronic equipment, saves time and money.

A room for fabrication of treatment aids and immobilization devices is necessary.

Facilities for the secure storage of radioactive brachytherapy sources are essential.

TABLE VIII-1
MINIMUM* PERSONNEL REQUIREMENTS FOR
CLINICAL RADIATION THERAPY

Category	Staffing
Radiation Oncologist-in-Chief	One per program
Staff Radiation Oncologist	One additional for each 200-250 patients treated annually. No more than 25-30 patients under treatment by a single physician.
Radiation Physicist	One per center for up to 400 patients annually. Additional in ratio of 1 per 400 patients treated annually
Treatment Planning Staff	
Dosimetrist or Physics Assistant	One per 300 patients treated annually
Physics Technologist (Mold Room)	One per 600 patients treated annually
Radiation Therapy Technologist	
Supervisor	One per center
Staff (Treatment)	2 per megavoltage unit up to 25 patients treated daily per unit 4 per megavoltage unit up to 50 patients treated daily per unit
Staff (Simulation)	2 for every 500 patients simulated annually
Staff (Brachytherapy)	
Treatment Aid	As needed, usually one per 300-400 patients treated annually
Nurse**	One per center for up to 300 patients treated annually and an additional one per 300 patients treated annually
Social Worker	As needed to provide service
Dietitian	As needed to provide service
Physical Therapist	As needed to provide service
Maintenance Engineer/Electronics Technician	One per 2 megavoltage units or 1 megavoltage unit and a simulator if equipment serviced "in-house"

*Additional personnel will be required for research, education and administration. For example, if 800 patients are treated annually with 3 accelerators, one ⁶⁰Co teletherapy unit, a superficial x-ray machine, one treatment planning computer, the clinical allotment for physicists would be 2-3. A training program with 8 residents, 2 technology students and a graduate student would require another 1-1.5 FTEs. Administration of this group would require 0.5 FTE. If the facility had 20% time for research, a total of 5-6 physicists would be required.

**For direct patient care. Other activities supported by LVNs and nurses aides.

TABLE VIII-3
RADIATION THERAPY UNITS

Type of Equipment	Maximum Beam Energy		Characteristics
	X or Gamma Rays	Electrons	
Superficial X-ray Units	0.1	—	High dose at surface Shallow penetration of X-rays
Orthovoltage X-ray Units	0.3	—	High dose at surface Moderate penetration of X-rays
Linear Accelerators			
Low Energy	4-6		Large field sizes High dose rates, skin sparing Sharp beam margins
High Energy	> 10	to 25	Good depth dose characteristics
Betatron	25-45	to 45	Small field sizes Low dose rates Good depth dose characteristics
Microtron	5-50	to 50	Similar to those of linear accelerators
Radioactive Isotope Unit			
Cobalt-60	1.2		Acceptable field sizes, dose rates and depth dose characteristics if SSD ≥ 80 cm Large penumbra

TABLE VIII-2
KEY STAFF FUNCTIONS IN CLINICAL RADIATION THERAPY

	KEY STAFF	SUPPORTIVE ROLE
CLINICAL EVALUATION	Radiation Oncologist	
THERAPEUTIC DECISION	Radiation Oncologist	
TARGET VOLUME LOCALIZATION		
Tumor Volume	Rad. Oncologist & Physicist	Sim. Tech./Dosimetrist
Sensitive Critical Organs	Radiation Oncologist	Sim. Tech./Dosimetrist
Patient Contour	Physicist	Sim. Tech./Dosimetrist
TREATMENT PLANNING		
Beam Data-Computerization	Physicist	Dosimetrist
Computation of Beams	Physicist	Radiation Oncologist/Physicist
Shielding Blocks	Dosimetrist/	
Treatment Aids, etc.	Mold Room Tech.	
Analysis of Alternate Plans	Radiation Oncologist/Physicist	Dosimetrist
Selection of Treatment Plan	Radiation Oncologist/Physicist/Dosimetrist	Physicist
Dose Calculation	Dosimetrist	
SIMULATION/VERIFICATION OF TREATMENT PLAN	Radiation Oncologist/	Dosimetrist/Physicist
	Sim. Tech.	
TREATMENT		
First Day Set-Up	Radiation Oncologist/Dosimetrist	Dosimetrist/Physicist
	Therapy Techs	
Localization Films	Radiation Oncologist/Therapy Techs	Dosimetrist/Physicist
Daily Treatment	Radiation Therapy Tech	
EVALUATION DURING TREATMENT	Radiation Oncologist Nurse	Radiation Therapy Tech Social Worker Dietician
FOLLOW-UP EXAMS	Radiation Oncologist Nurse	Data Manager Social Worker Dietician

IX. ECONOMIC ISSUES

Until recently, the environment for reimbursement for radiation oncology was acceptance of "usual and customary" charges based on patterns developed over many years. This resulted in wide variations locally and nationally.

Major changes have recently occurred. In July, 1985, it became mandatory that Medicare billing utilize Current Procedural Terminology (CPT) for reporting medical services performed by physicians. Soon thereafter, the Health Care Finance Administration (HCFA) issued Transmittal 1200 redefining the concept of daily and weekly patient management. Shortly afterwards, a Resource Based Relative Value Scale (RBRVS), designed in the Harvard School of Public Health, was introduced for Diagnostic Radiology. This has been extended to Radiation Oncology.

A consequence of the use of RBRVS is that reimbursement levels for radiation oncology units will be similar whether hospital-based or free-standing. Likewise geographic variations will be reduced and eventually eliminated.

These changes are not designed to reduce high quality patient care, but they will require documented justification for new equipment, programs and personnel. Innovation and research necessary to improve the radiation treatment of patients with cancer may become more difficult to support.

In the immediate future, billing and reimbursement must be updated to current practices, and CPT and RVS codes must be properly related (a users guide has been issued by the American College of Radiology).

X. CONCLUSIONS

The primary goal of cancer management is to provide every patient with the best possible management regardless of constraints. Secondary goals include continuing improvement of treatment through the development of better methods and the training of personnel.

Radiation therapy is an integral component of the management of 50-60% of patients with cancer in the United States. To ensure maximum effectiveness and minimal treatment induced morbidity, the modality must be used as well as current knowledge and technology permit.

In this report, guidelines are proposed for optimal use based on standards for personnel, equipment, facilities and operations.

XI. GLOSSARY

Accelerated Fractionation—The use of multiple daily increments, each equal to or less than a standard daily increment (i.e., 180–200 cGy), for an overall time which is shorter than standard.

Betatron—An accelerator first used for radiotherapy in the 1950s prior to the introduction of linear accelerators. Although X-ray and electron beams can be provided over a wide range of energies, the low dose rates and limited field sizes result in an unfavorable comparison with modern linear accelerators.

Brachytherapy—A method of treatment using sealed radioactive sources to deliver radiations at short distances by interstitial, intracavitary or surface applications.

Cancer—A term inclusive of a variety of malignant neoplasms; derived from the Latin word for crab.

Cesium-137—A radioactive isotope with a half-life of 30 years; emits gamma radiations with an energy of 660 keV most commonly used in intracavitary sources; found early use as teletherapy sources and in interstitial needle sources; sometimes used in remote afterloading brachytherapy.

Cobalt-60—A radioactive isotope with a half-life of 5.3 years; emits gamma radiations (1.17 and 1.33 MeV); used as a teletherapy source; found early use in interstitial and intracavitary needle sources; sometimes used in remote afterloading brachytherapy.

Cure—Actually implies complete restitution to predisease status; may be used for that situation when, after a disease-free, post-treatment interval, the survivors have a progressive death rate from *all* causes similar to that of a normal population of the same age and sex.

Dosimetrist—A member of the radiation therapy planning team who must be familiar with the physical characteristics of the radiation generators and radioactive sources used to treat patients; training and expertise necessary to generate and calculate radiation dose distributions, under the direction of the medical physicist and radiation oncologist, are necessary.

Electron—An atomic particle with a negative electric charge which may be accelerated to strike a target and produce X-rays or used collectively as a beam for treatment.

Gamma Rays—Electromagnetic (photon) radiations which are emitted from an unstable atomic nucleus; for example, gamma rays are emitted from Cesium-137, Cobalt-60 and Radium-226.

Hyperfractionation—The use of multiple daily increments, each considerably smaller than a standard daily increment, over a conventional period.

Hyperthermia—Elevation of the body temperature regionally (i.e., 42–45°C) or systemically (i.e., 41.8°C) resulting in direct cell killing and augmentation of the effects of other cytotoxic agents.

Interstitial Radiation Therapy—Sealed radioactive sources within special applicators placed in tissue in a preconceived pattern.

Intracavitary Radiation Therapy—Radioactive sources in closed containers placed in body cavities, i.e., uterus, vagina.

Ionizing Radiations—Radiant energy which is absorbed by a process of imparting its energy to atoms through the removal of orbital electrons.

Iridium-192—A radioactive isotope with a half-life of 74 days; emits gamma (300–600 keV) radiations; used in interstitial therapy; sometimes used in remote afterloading brachytherapy.

Linear Accelerator—A device in which particles (i.e., electrons, protons) can be accelerated to high energies along a straight path using microwave technology.

Linear Energy Transfer (L.E.T.)—A measure of the average rate of energy loss along the track of a charged particle, expressed as energy units per unit track length.

Medical Radiation Physicist—A professional with at least a master's degree and usually a Ph.D. in physics plus additional training and experience in diagnostic and/or therapeutic radiologic physics; most are certified by the American Board of Radiology or its equivalent.

Megavoltage Radiations—An ill-defined, frequently used term for ionizing radiations with energies equal to or greater than 1 MV.

Microtron—An electronic generator similar in principle to a linear accelerator but with magnetic bending of the electron paths into circular orbits; a single generator may supply beams to several treatment rooms.

Oncology—The study of tumors; no specific relationship to a medical discipline; applies to surgery, radiology, internal medicine, pediatrics and gynecology.

Orthovoltage X-rays—A term which applies to X-rays of insufficient energy to be "skin-sparing" or to avoid preferential absorption in bone; usually generated at 150–400 kVp; may be divided into superficial and deep X-rays, although often used interchangeably with deep X-ray.

Palliation—Relief or prevention of symptoms or signs caused by disease.

Penumbra—Those radiations just outside and adjacent to the full beam including components from incomplete beam collimation and scatter from the primary beam.

Radiation Dose—Energy imparted per unit mass of absorber at a specific site under certain conditions (absorbed d., threshold d., tumor d., depth d., permissible d.).

Radiation Oncologist—A physician with a special interest and competence in managing patients with cancer; minimal requirements include an M.D. degree, a year of general clinical training, three to four years of specialized training and certification by the American Board of Radiology or its equivalent.

Radiation Oncology—A clinical medical specialty with a specific involvement with tumors, particularly as they relate to treatment with ionizing radiations.

Radiation Oncology Nurse—A registered professional nurse who, as part of the radiation oncology team, provides appropriate direct intervention to aid the patient and family with problems related to the disease, treatment and follow-up evaluation; recommended minimal qualifications include a baccalaureate degree in nursing, two years experience in medical-surgical nursing and at least one year's experience in oncology nursing.

Radiation Therapy—Treatment of tumors and a few specific non-neoplastic diseases with ionizing radiations.

Radiation Therapy Technologist—A highly skilled professional who is qualified by training and experience to provide treatment with ionizing radiations under the supervision of a radiation oncologist.

Radioactivity—Emission of radiations from the breakdown of unstable nuclei which occurs naturally or is artificially produced.

Radionuclide—A radioactive form of a nuclide, which is any nuclear species of a chemical element capable of existing for a measurable time; often an isotope, with the same number of protons but a different number of neutrons. is referred to as a nuclide.

Simulation—Meaning to pretend; in radiation therapy, the precise mock-up of a patient treatment with radiographic documentation of the treatment portals.

Stereotactic Radiation Therapy—A method using three-dimensional target localization, which enables precise irradiation of small intracranial lesions.

Superficial X-rays—Minimally penetrating X-rays of low peak energy, generated by voltages in the range of 85–140 kV; used to treat lesions on the body surface.

Attachment 5

Table 3: 2021 Cancer Incidence and Mortality by County

	Incidence		Mortality	
	Cases	Rate	Deaths	Rate
North Carolina	64,901	494.7	20,225	152.8
Alamance	1,172	540.3	368	162.1
Alexander	243	449.4	98	174.0
Alleghany	86	436.6	31	137.9
Anson	174	582.0	58	190.4
Ashe	226	490.0	74	143.6
Avery	138	507.5	42	150.4
Beaufort	373	508.5	138	177.9
Bertie	132	467.6	53	179.2
Bladen	197	422.2	79	159.8
Brunswick	1,400	496.6	441	157.0
Buncombe	1,867	481.0	563	138.8
Burke	608	464.6	210	152.7
Cabarrus	1,213	486.0	320	132.8
Caldwell	588	501.7	214	175.8
Camden	44	334.6	23	184.1
Carteret	567	494.3	200	153.9
Caswell	182	507.9	63	168.0
Catawba	942	430.4	379	172.5
Chatham	660	515.3	169	117.6
Cherokee	276	507.3	93	155.5
Chowan	113	490.0	45	189.2
Clay	108	462.7	31	116.4
Cleveland	706	536.5	225	166.0
Columbus	378	530.0	137	183.6
Craven	671	498.5	249	171.7
Cumberland	1,705	513.9	588	179.4
Currituck	132	334.5	55	143.3
Dare	289	468.1	92	161.3
Davidson	1,233	523.4	392	164.8
Davie	336	513.5	97	139.7
Duplin	334	508.9	111	157.8
Durham	1,650	468.1	442	129.1
Edgecombe	358	522.5	135	190.3
Forsyth	2,414	509.8	719	151.2

Rates are per 100,000 persons and are age-adjusted to the 2000 U.S. Census.

Cancers of the urinary bladder and female breast include in situ cases.

Brain and other central nervous system cancer excludes benign cases.

**Cancer incidence rates for cell sizes with fewer than 16 cases of cancer and cancer mortality rates based on any cancer deaths less than 16 are suppressed as they are not stable.

Rates are calculated using vintage 2022 non-bridged population estimates, based on the 2020 Census.

Table 3 (continued): 2021 Cancer Incidence and Mortality by County

	Incidence		Mortality	
	Cases	Rate	Deaths	Rate
Franklin	472	512.7	141	156.3
Gaston	1,563	546.7	504	172.9
Gates	61	350.3	30	181.8
Graham	68	574.2	27	201.1
Granville	414	511.6	122	148.7
Greene	145	550.6	43	167.5
Guilford	3,260	507.5	1,015	160.3
Halifax	336	446.2	147	193.1
Harnett	711	496.9	252	178.5
Haywood	504	483.2	184	169.2
Henderson	961	489.0	322	150.6
Hertford	137	438.7	52	162.2
Hoke	256	519.7	86	192.2
Hyde	40	544.1	9	**
Iredell	1,195	499.9	343	144.0
Jackson	259	460.1	65	104.7
Johnston	1,299	515.3	386	159.9
Jones	77	491.0	22	127.3
Lee	366	452.2	123	150.6
Lenoir	364	469.7	124	141.7
Lincoln	635	504.3	185	148.5
McDowell	354	550.3	121	178.2
Macon	288	416.2	103	143.4
Madison	154	492.1	49	150.0
Martin	188	538.1	64	180.8
Mecklenburg	5,495	493.1	1,334	126.8
Mitchell	127	512.7	52	189.6
Montgomery	171	438.6	55	131.8
Moore	753	490.2	280	164.9
Nash	566	441.9	215	158.5
New Hanover	1,457	485.0	467	149.6
Northampton	150	486.8	53	158.6
Onslow	866	542.1	318	206.4
Orange	829	490.2	207	122.2
Pamlico	108	464.8	38	145.0

Rates are per 100,000 persons and are age-adjusted to the 2000 U.S. Census.

Cancers of the urinary bladder and female breast include *in situ* cases.

Brain and other central nervous system cancer excludes benign cases.

**Cancer incidence rates for all cell sizes with fewer than 16 cases of cancer and cancer mortality rates based on any cancer deaths less than 16 are suppressed as they are not stable

Rates are calculated using vintage 2022 non-bridged population estimates, based on the 2020 Census.

Table 3 (continued): 2021 Cancer Incidence and Mortality by County

	Incidence		Mortality	
	Cases	Rate	Deaths	Rate
Pasquotank	215	405.3	103	185.8
Pender	468	559.8	129	155.3
Perquimans	116	507.5	33	134.6
Person	296	530.0	104	177.6
Pitt	886	477.7	300	164.1
Polk	182	489.2	71	175.3
Randolph	976	501.2	353	182.2
Richmond	314	551.7	119	214.6
Robeson	666	478.0	275	198.9
Rockingham	691	515.9	226	164.8
Rowan	923	469.7	314	161.2
Rutherford	548	573.6	173	172.9
Sampson	389	510.2	144	179.8
Scotland	242	534.8	90	202.0
Stanly	445	532.5	171	197.3
Stokes	339	471.8	109	155.2
Surry	521	503.4	183	170.8
Swain	122	614.8	44	228.9
Transylvania	275	409.4	96	138.5
Tyrrell	22	412.0	10	**
Union	1,285	476.7	328	129.0
Vance	287	527.4	117	196.0
Wake	5,666	475.7	1,331	119.5
Warren	169	535.0	57	157.2
Washington	98	593.4	33	197.6
Watauga	294	467.9	75	119.0
Wayne	824	581.4	258	179.0
Wilkes	456	458.5	163	147.4
Wilson	512	496.7	209	194.6
Yadkin	296	548.5	82	145.5
Yancey	169	528.1	53	155.3

Rates are per 100,000 persons and are age-adjusted to the 2000 U.S. Census.

Cancers of the urinary bladder and female breast include in situ cases.

Brain and other central nervous system cancer excludes benign cases.

** Cancer incidence rates for all cell sizes with fewer than 16 cases of cancer and cancer mortality rates based on any cancer deaths less than 16 are suppressed as they are not stable.

Rates are calculated using vintage 2022 non-bridged population estimates, based on the 2020 Census.

Age-Adjusted to the 2000 U.S. Standard Population

COUNTY	COLON/RECTUM				LUNG/BRONCHUS				MELANOMA (SKIN)				ALL CANCERS			
	Cases	Rate	Lower_CI	Upper_CI	Cases	Rate	Lower_CI	Upper_CI	Cases	Rate	Lower_CI	Upper_CI	Cases	Rate	Lower_CI	Upper_CI
NORTH CAROLINA	21,956	34.7	34.2	35.1	40,819	58.6	58.0	59.2	18,082	28.5	28.1	29.0	316,896	481.5	479.8	483.2
Alamance	425	40.1	36.3	44.2	745	64.7	60.0	69.6	261	23.9	21.0	27.1	5,547	508.4	494.7	522.3
Alexander	70	27.6	21.2	35.5	172	60.9	51.9	71.2	103	41.4	33.4	50.9	1,140	431.0	405.3	458.1
Alleghany	26	28.9	18.0	45.1	70	63.4	48.6	82.7	23	20.9	13.0	33.7	400	397.5	355.7	443.8
Anson	72	48.5	37.6	61.9	114	67.9	55.7	82.4	28	19.2	12.5	28.5	835	544.5	506.6	584.8
Ashe	57	23.5	17.5	31.4	139	51.8	43.3	62.0	96	47.3	37.3	59.4	1,046	453.0	423.4	484.4
Avery	39	30.4	21.2	42.8	69	47.4	36.5	61.1	51	36.2	26.5	48.9	610	441.8	405.8	480.7
Beaufort	138	40.4	33.4	48.7	228	56.5	49.1	64.9	74	22.3	17.0	28.9	1,798	492.5	467.9	518.1
Bertie	48	38.7	27.7	52.9	87	59.2	46.8	74.5	14	**	**	**	652	469.3	430.9	510.6
Bladen	79	35.6	27.7	45.3	157	57.7	48.8	68.1	45	20.6	14.5	28.5	1,017	432.1	404.2	461.7
Brunswick	465	35.7	31.9	39.9	895	54.2	50.3	58.4	553	38.7	35.0	42.8	7,012	483.0	469.5	496.8
Buncombe	609	32.7	30.1	35.5	1,124	54.6	51.4	58.0	600	33.1	30.4	36.1	8,918	484.6	454.6	474.8
Burke	240	38.2	33.3	43.6	484	67.6	61.6	74.2	193	32.1	27.5	37.4	3,143	478.6	461.1	496.6
Cabarrus	430	35.2	31.9	38.7	698	54.9	50.8	59.2	308	25.2	22.4	28.2	5,877	471.2	459.0	483.6
Caldwell	246	43.7	38.1	50.0	453	69.6	63.2	76.6	194	34.4	29.5	40.0	3,131	526.5	507.3	546.3
Camden	29	41.6	27.4	61.2	29	41.0	27.1	60.1	20	30.9	18.4	49.1	249	359.8	315.1	409.6
Carteret	174	31.3	26.4	36.9	408	63.9	57.5	71.0	266	48.6	42.3	55.7	2,758	472.0	452.7	492.0
Caswell	60	37.3	27.9	49.1	167	87.5	74.2	102.9	44	26.0	18.4	36.1	852	492.5	457.6	529.5
Catawba	299	29.1	25.8	32.8	593	51.4	47.2	55.8	440	42.1	38.2	46.5	4,709	436.3	423.4	449.4
Chatham	210	35.7	30.6	41.4	317	44.3	39.4	49.8	229	36.9	31.9	42.6	3,095	483.4	465.3	502.2
Cherokee	113	45.9	36.8	57.1	207	64.9	55.8	75.6	60	24.0	17.6	32.4	1,225	450.1	421.6	480.3
Chowan	42	34.9	24.5	49.1	64	51.3	39.1	67.0	29	24.5	15.8	37.1	551	488.9	445.0	536.5
Clay	38	37.0	24.3	55.2	80	63.6	49.5	82.1	21	15.9	9.7	27.2	518	444.7	401.9	491.9
Cleveland	265	44.5	39.3	50.4	527	72.3	66.1	79.0	194	30.3	26.0	35.2	3,428	511.5	493.7	529.8
Columbus	142	41.4	34.6	49.3	253	64.1	56.3	72.9	103	29.1	23.5	35.7	1,724	477.8	454.5	502.1
Craven	227	36.2	31.4	41.6	529	71.9	65.6	78.6	191	28.0	23.9	32.6	3,445	499.0	481.5	517.0
Cumberland	462	28.9	26.3	31.7	1,034	61.0	57.3	64.9	269	16.8	14.8	19.0	7,508	454.4	444.0	465.1
Currittuck	37	19.8	13.6	28.1	97	47.8	38.3	59.2	44	24.0	17.1	33.0	619	317.6	291.5	345.4
Dare	82	27.0	21.0	34.5	170	50.8	43.2	59.8	129	46.7	38.2	56.8	1,318	435.2	410.0	461.8
Davidson	446	40.5	36.7	44.7	908	72.6	67.9	77.6	349	31.5	28.1	35.2	5,857	500.8	487.5	514.3
Davie	122	38.3	31.4	46.3	230	64.5	56.3	73.8	115	36.1	29.5	44.0	1,666	510.2	484.7	536.9
Duplin	141	41.7	34.8	49.6	239	62.1	54.3	70.8	58	18.1	13.5	23.8	1,715	495.6	471.3	520.9
Durham	472	28.1	25.6	30.9	778	43.9	40.8	47.2	486	27.9	25.4	30.5	7,971	450.9	440.8	461.2
Edgecombe	108	32.9	26.6	40.3	241	62.9	54.9	71.9	43	12.0	8.5	16.6	1,692	483.6	459.4	506.9
Forsyth	741	32.6	30.2	35.1	1,462	58.9	55.9	62.1	526	22.8	20.9	24.9	11,610	489.2	480.1	498.5
Franklin	148	32.8	27.5	38.8	288	57.9	51.2	65.3	115	26.6	21.7	32.3	2,205	471.2	450.9	492.2
Gaston	589	42.4	39.0	46.1	1,054	69.4	65.2	73.8	495	36.1	32.9	39.5	7,562	530.0	517.8	542.4
Gates	20	24.9	14.6	40.7	36	42.2	29.0	60.5	11	**	**	**	230	270.5	235.0	310.7
Graham	20	31.5	18.3	51.9	53	74.2	55.2	99.4	11	**	**	**	275	423.6	371.3	482.2
Granville	199	51.9	44.6	60.0	293	67.0	59.4	75.4	93	23.8	19.0	29.6	2,107	515.2	492.6	538.6

COUNTY	COLON/RECTUM				LUNG/BRONCHUS				MELANOMA (SKIN)				ALL CANCERS			
	Cases	Rate	Lower_CI	Upper_CI	Cases	Rate	Lower_CI	Upper_CI	Cases	Rate	Lower_CI	Upper_CI	Cases	Rate	Lower_CI	Upper_CI
Greene	38	28.7	20.1	40.1	90	65.8	52.6	81.5	20	16.3	9.8	25.7	618	464.5	427.5	504.1
Gulfford	1,059	34.3	32.2	36.5	1,923	58.3	55.7	61.0	863	27.5	25.6	29.4	15,705	492.7	484.8	500.6
Halifax	123	34.8	28.5	42.2	240	61.4	53.7	70.1	47	13.3	9.6	18.1	1,723	478.1	454.4	502.8
Harnett	248	35.5	31.1	40.3	518	69.3	63.4	75.7	132	18.9	15.7	22.4	3,383	488.1	452.2	484.5
Haywood	200	41.8	35.8	48.7	380	67.4	60.6	75.1	150	30.1	25.1	36.0	2,543	490.4	470.1	511.6
Henderson	310	33.6	29.6	38.0	553	50.4	46.2	55.1	334	33.9	30.1	38.1	4,768	485.8	471.0	501.1
Hertford	52	33.1	24.4	44.4	101	58.9	47.8	72.4	8	**	**	**	687	448.8	413.8	486.2
Hoke	85	36.4	28.7	45.4	179	71.6	61.1	83.5	34	14.3	9.7	20.2	1,174	463.1	435.7	491.7
Hyde	20	54.1	31.7	88.9	26	60.8	39.1	93.8	13	**	**	**	185	492.0	418.5	576.6
Iredell	402	34.4	31.0	38.1	735	57.8	53.6	62.3	437	37.9	34.4	41.8	5,692	474.3	461.7	487.2
Jackson	94	34.4	27.4	42.8	148	46.9	39.3	55.6	94	33.5	26.7	41.7	1,244	434.4	409.0	461.1
Johnston	411	34.0	30.7	37.6	887	71.2	66.5	76.2	312	26.3	23.4	29.5	6,370	513.0	500.1	526.1
Jones	29	43.9	28.0	66.4	72	84.2	65.2	108.6	9	**	**	**	376	498.9	445.4	557.8
Lee	149	37.7	31.7	44.5	277	64.5	56.9	72.8	79	20.2	15.9	25.5	1,886	489.1	447.5	491.5
Lenoir	130	36.8	30.3	44.3	297	69.9	61.9	78.7	85	21.5	16.9	27.0	1,987	501.6	478.3	525.8
Lincoln	206	35.4	30.5	40.9	435	65.7	59.5	72.5	245	41.1	35.9	47.0	3,082	492.7	474.6	511.2
McDowell	143	45.1	37.7	53.6	304	83.1	73.8	93.5	86	28.4	22.3	35.6	1,807	543.4	517.3	570.5
Macon	129	40.5	33.1	49.4	197	53.2	45.5	62.2	122	40.5	32.7	49.8	1,569	473.8	447.9	501.0
Madison	63	42.6	32.1	55.6	126	70.2	58.0	84.6	55	36.6	26.9	48.9	782	484.0	448.5	521.8
Martin	55	33.5	24.5	45.1	140	71.1	59.4	85.0	26	17.0	10.5	26.2	931	528.9	492.6	567.4
Mecklenburg	1,811	33.0	31.5	34.6	2,487	46.3	44.5	48.2	1,443	26.3	25.0	27.8	26,580	477.7	471.9	483.6
Mitchell	49	43.7	31.2	59.9	96	69.6	56.0	86.4	38	38.0	25.8	54.3	619	514.0	470.9	560.5
Montgomery	68	34.1	26.2	44.0	130	59.9	49.7	71.9	52	27.1	19.8	36.4	903	457.6	426.4	490.7
Moore	214	28.1	24.0	32.5	512	57.7	52.7	63.2	314	41.2	36.5	46.5	3,843	485.8	469.5	502.6
Nash	177	28.2	24.0	32.9	383	53.1	47.8	58.9	109	17.3	14.0	21.1	2,825	437.1	420.4	454.4
New Hanover	408	28.4	25.6	31.4	833	50.9	47.5	54.6	555	38.9	35.6	42.4	7,497	491.8	480.4	503.6
Northampton	53	38.2	27.2	52.6	119	70.6	57.1	87.2	26	15.2	9.8	23.7	745	483.1	444.3	524.9
Onslow	286	37.7	33.4	42.5	676	83.3	77.0	89.9	217	27.5	23.8	31.5	4,361	542.2	525.8	559.1
Orange	234	28.8	25.1	32.9	399	45.5	41.0	50.3	271	32.9	29.0	37.2	3,991	473.9	458.9	489.4
Pamlico	45	43.1	29.5	61.7	86	61.3	48.6	78.0	41	31.2	21.8	45.0	593	498.9	454.3	547.7
Pasquotank	94	37.0	29.6	45.7	148	52.4	44.1	61.9	58	25.7	19.2	33.6	1,026	390.6	366.1	416.3
Pender	161	38.9	32.9	45.7	279	60.1	53.0	67.9	123	31.1	25.7	37.5	2,258	535.7	512.9	559.2
Perquimans	39	35.2	23.9	50.7	71	54.8	41.9	71.5	23	19.3	11.7	31.1	483	419.2	378.1	464.0
Person	112	41.3	33.6	50.4	200	63.0	54.3	72.9	83	30.7	24.1	38.8	1,428	492.5	465.8	520.4
Pitt	262	29.5	25.9	33.4	548	56.4	51.7	61.5	159	17.8	15.1	20.9	4,389	471.1	456.9	485.6
Polk	65	34.0	25.0	45.8	90	42.3	32.9	54.2	45	23.6	16.1	34.0	786	415.4	381.8	451.7
Randolph	354	38.6	34.5	43.0	783	73.1	67.9	78.6	281	30.8	27.2	34.9	4,828	500.5	486.0	515.4
Richmond	122	46.1	37.9	55.5	259	83.6	73.5	94.9	53	18.0	13.4	23.9	1,526	536.2	508.7	564.8
Robeson	269	37.5	33.1	42.5	557	74.5	68.3	81.1	71	11.0	8.5	14.0	3,287	464.2	448.0	481.0
Rockingham	255	39.8	34.8	45.4	603	80.1	73.7	87.0	180	27.4	23.3	32.0	3,580	526.1	508.1	544.7
Rowan	345	37.6	33.6	42.0	686	67.0	62.0	72.4	245	27.0	23.6	30.8	4,660	484.2	469.9	498.8
Rutherford	194	40.0	34.2	46.5	347	64.5	57.7	72.0	153	35.0	29.2	41.5	2,446	500.8	479.9	522.4
Sampson	128	32.8	27.2	39.2	322	76.5	68.2	85.6	85	23.9	18.9	30.0	1,939	501.4	478.6	525.2

COUNTY	FEMALE BREAST				CERVIX UTERI				PROSTATE				ALL CANCERS			
	Cases	Rate	Lower_Ci	Upper_Ci	Cases	Rate	Lower_Ci	Upper_Ci	Cases	Rate	Lower_Ci	Upper_Ci	Cases	Rate	Lower_Ci	Upper_Ci
Greene	116	200.3	162.7	244.4	5	**	**	**	94	137.0	109.5	169.7	618	464.5	427.5	504.1
Gulford	3,198	189.6	182.8	196.5	95	6.4	5.1	7.8	2,228	141.6	135.6	147.7	15,705	492.7	484.8	500.6
Halifax	311	168.5	148.6	190.5	10	**	**	**	228	126.8	110.3	145.3	1,723	478.1	454.4	502.8
Harnett	595	159.5	146.7	173.2	32	9.4	6.4	13.3	409	113.4	102.4	125.4	3,383	468.1	452.2	484.5
Haywood	388	153.2	136.6	171.3	7	**	**	**	296	105.8	93.8	119.2	2,543	490.4	470.1	511.6
Henderson	970	204.0	189.9	218.9	15	**	**	**	535	103.7	94.9	113.3	4,768	485.8	471.0	501.1
Hertford	127	163.7	133.5	199.3	*	*	*	*	121	160.0	131.7	193.2	687	448.8	413.8	486.2
Hoke	196	144.8	124.6	167.4	10	**	**	**	198	160.6	137.5	186.3	1,174	463.1	435.7	491.7
Hyde	23	127.9	75.3	209.7	*	*	*	*	29	161.6	104.2	243.3	185	492.0	418.5	576.6
Iredell	980	164.2	153.7	175.3	32	6.8	4.6	9.7	880	141.3	131.8	151.4	5,892	474.3	461.7	487.2
Jackson	190	140.5	119.6	164.3	14	**	**	**	158	102.9	87.0	121.3	1,244	434.4	409.0	461.1
Johnston	1,260	190.3	179.7	201.3	48	8.0	5.8	10.7	796	127.5	118.3	137.2	6,370	513.0	500.1	526.1
Jones	60	163.4	120.8	218.1	*	*	*	*	54	136.0	101.0	182.2	376	498.9	445.4	557.8
Lee	304	147.6	130.7	166.1	11	**	**	**	270	132.7	116.9	150.3	1,886	469.1	447.5	491.5
Lenoir	361	180.1	160.4	201.6	13	**	**	**	268	138.4	121.8	156.8	1,957	501.6	478.3	525.8
Lincoln	550	170.8	156.1	186.6	12	**	**	**	429	126.2	114.2	139.3	3,082	492.7	474.6	511.2
McDowell	278	169.5	148.7	192.7	13	**	**	**	203	116.1	100.2	134.0	1,807	543.4	517.3	570.5
Macon	249	151.6	130.4	175.6	7	**	**	**	171	92.4	78.7	108.6	1,569	473.8	447.9	501.0
Madison	138	165.2	138.7	198.5	6	**	**	**	73	86.2	67.0	110.2	782	484.0	448.5	521.8
Martin	179	190.7	161.4	224.4	13	**	**	**	129	147.1	121.9	177.2	931	528.9	492.6	567.4
Mecklenburg	5,886	192.8	187.9	197.9	190	6.6	5.7	7.6	3,941	147.9	143.2	152.8	26,580	477.7	471.9	483.6
Mitchell	101	177.2	141.2	220.6	*	*	*	*	78	114.0	89.7	144.7	619	514.0	470.9	580.5
Montgomery	129	133.9	109.9	162.1	*	*	*	*	116	108.2	88.9	131.2	903	457.6	426.4	490.7
Moore	637	163.8	150.1	178.5	16	5.9	3.2	9.9	636	155.5	143.3	168.5	3,843	485.8	469.5	502.6
Nash	566	174.0	159.1	190.0	13	**	**	**	370	111.2	99.8	123.7	2,825	437.1	420.4	454.4
New Hanover	1,389	169.8	160.5	179.5	47	7.7	5.6	10.4	938	123.4	115.5	131.8	7,497	491.8	480.4	503.6
Northampton	127	167.2	134.2	206.8	5	**	**	**	130	164.7	136.3	198.9	745	483.1	444.3	524.9
Onslow	659	160.1	147.7	173.2	42	10.9	7.8	14.9	497	128.6	117.1	140.8	4,361	542.2	525.8	559.1
Orange	816	189.6	176.3	203.6	14	**	**	**	540	126.5	115.7	138.0	3,991	473.9	458.9	489.4
Pamlico	82	140.7	106.9	184.4	*	*	*	*	96	142.2	114.0	178.3	593	498.9	454.3	547.7
Pasquotank	184	134.7	114.9	167.3	6	**	**	**	141	108.8	91.1	129.1	1,026	390.6	366.1	416.3
Pender	408	198.3	178.7	219.6	9	**	**	**	268	119.7	105.3	135.7	2,258	535.7	512.9	559.2
Perquimans	78	152.4	115.4	198.2	0	0	0	0	77	119.6	93.5	153.3	483	419.2	378.1	484.0
Person	273	181.2	158.9	206.0	5	**	**	**	186	125.7	107.7	146.4	1,428	492.5	465.8	520.4
Pitt	904	182.0	169.9	194.6	39	8.8	6.2	12.2	643	143.1	131.9	155.1	4,389	471.1	456.9	485.6
Polk	165	180.3	148.5	217.9	5	**	**	**	112	111.7	90.9	137.6	786	415.4	381.8	451.7
Randolph	830	174.0	161.8	187.0	29	7.7	5.0	11.2	558	109.1	100.0	118.8	4,828	500.5	486.0	515.4
Richmond	255	173.7	152.3	197.5	12	**	**	**	232	163.3	142.5	186.6	1,526	536.2	508.7	564.8
Robeson	588	159.4	146.3	173.5	30	10.4	7.0	15.0	533	151.2	138.3	165.1	3,287	464.2	448.0	481.0
Rockingham	663	191.6	176.3	208.1	27	10.1	6.4	15.1	411	117.8	106.3	130.4	3,580	526.1	508.1	544.7
Rowan	835	174.0	161.8	186.9	37	9.1	6.2	12.7	566	113.1	103.7	123.3	4,660	484.2	469.9	498.8
Rutherford	409	169.0	151.8	187.8	10	**	**	**	272	105.3	92.7	119.3	2,446	500.8	479.9	522.4
Sampson	335	177.5	158.0	198.9	14	**	**	**	248	123.9	108.6	140.9	1,939	501.4	478.6	525.2

Table 15C-1: Hospital and Free-Standing Linear Accelerators and Radiation Oncology Procedures

Facility Name	Service Area Number	County	Number of Linear Accelerators	Number of Procedures (ESTVs) 10/1/2023-9/30/2024	Average Number of Procedures per Unit
Harris Regional Hospital	1	Jackson	1	1,555	1,555
North Carolina Radiation Therapy Management Services - Franklin	1	Macon	1	1,330	1,330
Mission Hospital	2	Buncombe	3	16,081	5,360
North Carolina Radiation Therapy Management Services - Asheville	2	Buncombe	1	6,346	6,346
North Carolina Radiation Therapy Management Services - Weaverville	2	Buncombe	1	2,256	2,256
North Carolina Radiation Therapy Management Services - Clyde	2	Haywood	1	4,800	4,800
North Carolina Radiation Therapy Management Services - Marion	2	McDowell	1	3,800	3,800
Watauga Medical Center	3	Watauga	1	3,743	3,743
Margaret R. Pardec Memorial Hospital	4	Henderson	1	5,738	5,738
North Carolina Radiation Therapy Management Services - Hendersonville	4	Henderson	1	4,108	4,108
North Carolina Radiation Therapy Management - Brevard	4	Transylvania	1	1,462	1,462
UNC Health Blue Ridge-Valdese Campus	5	Burke	2	7,411	3,706
Caldwell Memorial Hospital****	5	Caldwell	1		
Catawba Valley Medical Center	5	Catawba	2	11,913	5,957
Frye Regional Medical Center - Main Campus	5	Catawba	1	1,847	1,847
Atrium Health Cleveland	6	Cleveland	1	6,657	6,657
CaroMont Regional Medical Center**	6	Gaston	3	22,293	7,431
North Carolina Radiation Therapy Management Services - Forest City	6	Rutherford	1	3,499	3,499
Atrium Health Carolinas Medical Center	7	Mecklenburg	3	19,787	6,596
Atrium Health Pineville	7	Mecklenburg	2	13,364	6,682
Atrium Health University City	7	Mecklenburg	1	9,533	9,533
Matthews Radiation Oncology Center	7	Mecklenburg	2	13,772	6,886
Novant Health Huntersville Medical Center	7	Mecklenburg	1	9,398	9,398
Novant Health Presbyterian Medical Center	7	Mecklenburg	2	12,636	6,318
Atrium Health Union	7	Union	1	8,622	8,622
Iredell Memorial Hospital	8	Iredell	2	4,717	2,359
Lake Norman Radiation Oncology	8	Iredell	1	7,526	7,526
Novant Health Rowan Medical Center	8	Rowan	1	7,052	7,052
Atrium Health Cabarrus	9	Cabarrus	3	13,895	4,632
Atrium Health Stanly	9	Stanly	1	4,236	4,236
Atrium Health Wake Forest Baptist Medical Center	10	Forsyth	4	22,986	5,747
Novant Health Forsyth Medical Center	10	Forsyth	5	26,736	5,347
Hugh Chatham Memorial Hospital****	10	Surry	1		
Lexington Medical Center	11	Davidson	1	3,233	3,233

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Table 15C-1: Hospital and Free-Standing Linear Accelerators and Radiation Oncology Procedures

Facility Name	Service Area Number	County	Number of Linear Accelerators	Number of Procedures (ESTVs) 10/1/2023-9/30/2024	Average Number of Procedures per Unit
Atrium Health Wake Forest Baptist - High Point Medical Center	12	Guilford	2	8,775	4,387
Cone Health Wesley Long Hospital	12	Guilford	4	31,476	7,869
UNC Rockingham Hospital	12	Rockingham	1	3,301	3,301
Randolph Health	13	Randolph	1	3,549	3,549
University of North Carolina Hospitals	14	Orange	6	41,413	6,902
Alamance Regional Medical Center	15	Alamance	2	11,284	5,642
Duke Regional Hospital	16	Durham	1	3,951	3,951
Duke University Medical Center	16	Durham	8	43,378	5,422
Maria Parham Health	16	Vance	1	3,535	3,535
FirstHealth Moore Regional Hospital*	17	Moore	3	8,557	2,852
Scotland Memorial Hospital	17	Scotland	1	1,794	1,794
Cape Fear Valley Medical Center	18	Cumberland	5	17,919	3,584
UNC Health Southeastern-Gibson Cancer Center	18	Robeson	2	7,285	3,642
North Carolina Radiation Therapy Management Services - Clinton	18	Sampson	1	2,454	2,454
Novant Health New Hanover Regional Medical Center***	19	New Hanover	5	38,950	7,790
Franklin County Cancer Center (closed)	20	Franklin	1		
2023 Need Determination	20	Wake	1		
Duke Raleigh Hospital	20	Wake	4	27,461	6,865
UNC Health Rex	20	Wake	4	22,543	5,636
UNC Health Rex Radiation Oncology-Holly Springs *	20	Wake	1		
UNC Rex Cancer Center of East Raleigh	20	Wake	1	2,899	2,899
Central Harnett Hospital *	21	Harnett	1		
Clayton Radiation Oncology	22	Johnston	1	6,349	6,349
Smithfield Radiation Oncology	22	Johnston	1	5,111	5,111
UNC Lenoir Health Care	23	Lenoir	1	6,229	6,229
North Carolina Radiation Therapy Management Services - Goldsboro	23	Wayne	1	5,682	5,682
Carteret Health Care	24	Carteret	2	7,694	3,847
CarolinaEast Medical Center	24	Craven	2	9,869	4,934
Onslow Radiation Oncology	25	Onslow	1	6,811	6,811
North Carolina Radiation Therapy Management Services - Roanoke Rapids	26	Halifax	1	2,496	2,496
Nash General Hospital	26	Nash	2	6,787	3,394
Wilson Radiation Oncology	26	Wilson	1	1,718	1,718
ECU Health Beaufort Hospital	27	Beaufort	1	3,669	3,669
Vidant Radiation Oncology	27	Hertford	1	2,800	2,800
Vidant Radiation Oncology	27	Pitt	3	17,234	5,745
Vidant Radiation Oncology	27	Pitt	1	8,443	8,443

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Table 15C-1: Hospital and Free-Standing Linear Accelerators and Radiation Oncology Procedures

Facility Name	Service Area Number	County	Number of Linear Accelerators	Number of Procedures (ESTVs) 10/1/2023-9/30/2024	Average Number of Procedures per Unit
Outer Banks Health Hospital	28	Dare	1	2,639	2,639
Sentara Radiation Oncology	28	Pasquotank	1	6,024	6,024
Totals (72 Facilities)			132	662,401	5,018

* Facility has a CON-approved linear accelerator under development.

** CaroMont Regional Medical Center has two linear accelerators in Gaston County and one linear accelerator in Lincoln County

*** New Hanover Regional Medical Center has four linear accelerators in New Hanover County and one linear accelerator in Brunswick County.

**** Facility has a linear accelerator but reported no procedures on their License Renewal Application or Registration and Inventory form.

Attachment 7

dlegarth@nc.rr.com

From: Emanuel, Andrea N <andrea.emanuel@dhhs.nc.gov>
Sent: Tuesday, July 1, 2025 3:39 PM
To: dlegarth@nc.rr.com
Subject: RE: [External] Current Patient Origin Tables

Hello –

Those will become available in late September/early October. The link will be posted [here](#).

Let me know if I can be of further assistance.

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Subject: [External] Current Patient Origin Tables

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Good Afternoon,

I wanted to check and see if the Patient Origin Tables are available for those SMFP services that require defining the multi-county service area based on current patient origin, such as acute care beds, operating rooms, and linear accelerators.

David Legarth



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Results From the ASCO 2019 Survey of Oncology Practice Operations

Brian Bourbeau, MBA¹; David Harter, BS¹; and Elaine Towle, CMPE²

abstract

The Survey of Oncology Practice Operations is an annual survey conducted by ASCO since 2016. This is the first year in which results have been published publicly for use by practice leaders to compare the performance of their practice. The scope of the 125-question survey instrument includes medical oncology, radiation oncology, drug administration, laboratory, imaging, point-of-care dispensing pharmacy, clinical research, and practice/service-line administration. Benchmarks available include measures of staffing, productivity, revenue, and expenses, as well as a salary survey for 27 oncology-specific positions. We encourage readers of this article to develop capabilities to replicate these benchmarks within their practice and to participate in future years' surveys.

JCO Oncol Pract 16:253-262. © 2020 by American Society of Clinical Oncology

INTRODUCTION

Benchmarking to one's peers allows practices to compare performance, set goals, and identify opportunities to improve performance. ASCO operates two benchmarking programs for members and their practices: the Quality Oncology Practice Initiative includes more than 150 measures of quality care and patient safety, and PracticeNET supports practice health with a focus on operational metrics.

Each year, PracticeNET conducts the Survey of Oncology Practice Operations (SOPO), a 125-question survey covering operational metrics in hematology/oncology, radiation oncology, drug administration, laboratory, imaging, point-of-care pharmacy, and clinical research. Each response is reviewed to ensure completeness and subjected to data quality standards to ensure the validity of each benchmark. Successful participation in SOPO provides practice leaders access to 109 benchmarks of staffing, productivity, revenue, salaries, and other expenses.

METHODOLOGY

A total of 712 physician and administrative leaders were invited to participate in the survey, representing approximately 400 practices. Survey participants were identified through participation in one or more ASCO practice health and/or quality improvement programs,

active members of ASCO with the membership type of Practice Administrator, and other leadership contacts gathered by ASCO staff.

Participants received e-mail invitations to the SOPO survey, which was made available from February 4, 2019 to March 15, 2019. Participants were asked to submit one response per practice, for the calendar year 2018. Participants who submitted partial or unclear responses received follow-up communications until such time that we received improved responses or believed additional contact was futile.

Participants were given multiple options to submit complete survey information. All survey questions were available online. Participants who were members of ASCO's PracticeNET collaborative—PracticeNET is a free benchmarking service available to ASCO members and their practices—had previously submitted monthly productivity information throughout 2018 and were not required to restate these numbers in the survey.

Quality Standards

We subjected each survey response to numerous quality checks. Among the 110 initial responses, we first identified 10 duplicates, which we either deleted or coalesced into a single result. Furthermore, we subjected all responses to the following tests to ensure data accuracy:

ASSOCIATED

CONTENT

Appendix

See accompanying oncographic on page 249

Author affiliations and support information (if applicable) appear at the end of this article.

Accepted on March 15, 2020 and published at ascopubs.org/journal/op on May 12, 2020; DOI: <https://doi.org/10.1200/OP.20.00009>

TABLE 1. Accepted Survey Responses

Practice	Practice Type	State	Respondent
Arizona Oncology	Physician-owned practice	AZ	Paul Brosor
Bon Secours Hematology and Oncology	Hospital-owned practice	SC	Theresa Standifer
Cancer & Hematology Centers of West Michigan	Physician-owned practice	MI	Cindy Powers
Cancer Care Partnership	Hospital-owned practice	PA	Stephen Speece
Center for Cancer and Blood Disorders	Physician-owned practice	TX	Felicia Wheeler
Charleston Area Medical Center	Hospital-owned practice	WV	Beverly Farmer
Epic Care	Physician-owned practice	CA	Bill Murphy
Harbin Clinic	Physician-owned practice	GA	Janice Hopkins
Hematology Oncology	Other	CT	Judy Stone
Hematology Oncology Physicians of Englewood	Other	NJ	Cheryl Hodges
IHA Hematology Oncology Consultants	Other	MI	Anne Gentz
John B. Amos Cancer Center	Hospital-owned practice	GA	William Brouwer
Low Country Cancer	Physician-owned practice	GA	Jim Tucker
Marin Cancer Care	Physician-owned practice	CA	Harvey Bickhoff
McFarland Clinic	Hospital-owned practice	IA	Lynn Lanning
Mid-Florida Hematology and Oncology Centers	Physician-owned practice	FL	Harish Gowda
Minnesota Oncology	Physician-owned practice	MN	Rhonda Henschel
Montana Cancer Center at Providence St Patrick Hospital	Hospital-owned practice	MT	Kristy Beck-Nelson
Nebraska Hematology Oncology	Physician-owned practice	NE	Amy King
New England Cancer Specialists	Physician-owned practice	ME	Isabella Bouffard
New Hampshire Oncology	Physician-owned practice	NH	Dan Smith
Oncology Hematology Care	Physician-owned practice	OH	Abbey Cole
Oncology Specialties	Physician-owned practice	AL	Michelle Brown
OSF Saint Anthony Medical Center Patricia D Pepe Center for Cancer Care	Hospital-owned practice	IL	Thelma Baker
Pacific Shores Medical Group	Physician-owned practice	CA	Jim Mopsikoff
Providence Regional Cancer System Lacey	Hospital-owned practice	WA	Ryan Moore
Providence Cancer OR Region	Hospital-owned practice	OR	Courtney Wood
Providence St Mary Regional Cancer Center	Hospital-owned practice	WA	Hall Grimes
Queens Medical Associates	Physician-owned practice	NY	Sadiaka Joarder
Quincy Physicians & Surgeons Clinic	Physician-owned practice	IL	Melissa Bradfield
RCCA Center for Cancer and Blood Disorders	Physician-owned practice	MD	Carreen Huffman
Swedish Cancer Institute	Hospital-owned practice	WA	Selin Demir
Tennessee Oncology	Physician-owned practice	TN	Sharon Donatelli
The Christ Hospital Medical Specialists II	Hospital-owned practice	OH	Kristina Wilber
UNC REX Cancer Care	Hospital-owned practice	NC	Matthew Evans
University of Michigan Rogel Cancer Center	Academic practice	MI	Julie Brabbs
Ventura County Hematology Oncology Specialists	Physician-owned practice	CA	Lynn Kong
West Michigan Cancer Center	Other	MI	Sherry Hirst

- Participants reporting hematology/oncology services must have answered the question for the number of full-time equivalent (FTE) hematologist/oncologists or radiation oncologists.
- Practice-average work relative value units (wRVU) must have been reported and averaged between 2,500 and 18,000 per hematologist/oncologist or radiation oncologist.
- Practice-average new patient/consult visit counts must have been reported and averaged between 50 and 1,000 visits per hematologist/oncologist.
- Practice-average established patient visits must have been reported and averaged between 1,000 and 8,000 per hematologist/oncologist.

These quality standards are based on our prior survey and benchmarking experience. After application of these quality tests, we were left with 38 accepted responses, representing 638 FTE physicians. Certain benchmarks, such as staffing levels, staff pay, and other financials, required additional data. Some participants were excluded from one or more of these measures because of lack of sufficient information; the caption for each figure includes the number of practices and physicians represented.

Metrics

Most benchmarks were calculated on a per-physician basis. Participants were asked to report the number of FTE hematologists/oncologists (FTE HemOnc), radiation oncologists (FTE RadOnc), and other specialists for their practice on the basis of a standard of four clinic days per week, clinic business at least part of the fifth day, and shared call. Throughout the report, the value of 7,000 wRVUs is used to calculate a standardized hematologist/oncologist (STD HemOnc), an alternative denominator to FTE HemOnc. The benefit of the STD HemOnc denominator is that it equalizes staffing levels and expenses on the basis of a standard expectation of physician productivity. Benchmarks may be presented per FTE HemOnc, STD HemOnc, FTE RadOnc, and/or FTE physician.

Most benchmarks are calculated with their 25th, 50th, and 75th percentile, along with an unweighted average and a weighted adjusted average using a least squares method (adjusted average = $\frac{\sum_{i=1}^n \frac{a_i}{\sqrt{d_i}}}{\sum_{i=1}^n \frac{1}{\sqrt{d_i}}}$). Throughout this article, use of this adjusted average is preferred when available.

Confidentiality

Confidentiality of practice and physician data is a key component of SOPO and other PracticeNET programs.

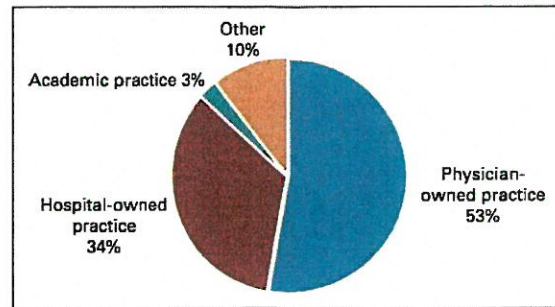


FIG 1. Accepted responses by practice type in 38 practices; full-time equivalent physicians (n = 637.6).

SOPO reports are either reported by aggregation (such as this article) or using randomly generated practice keys. Care is taken not to identify individual data points by practice name or other identifying information, such as the raw number of physicians or geography.

RESULTS

Demographics

Survey respondents reported their roles as either physician (3%), chief executive officer/executive director (13%), practice administrator/office manager (52%), director of finance (16%), or other (16%).

Among the 38 accepted responses, 20 were from physician-owned practices, 13 from nonacademic hospital-owned practices, one from an academic practice, and four reporting another arrangement (Table 1; Fig 1). These results diverge from prior surveys published by *JCO Oncology Practice*, which heavily favored physician-owned practices.¹ The diversity in practice setting is reflective of concerted outreach to a broad collection of practices and does not necessarily reflect a change in national practice demographics.

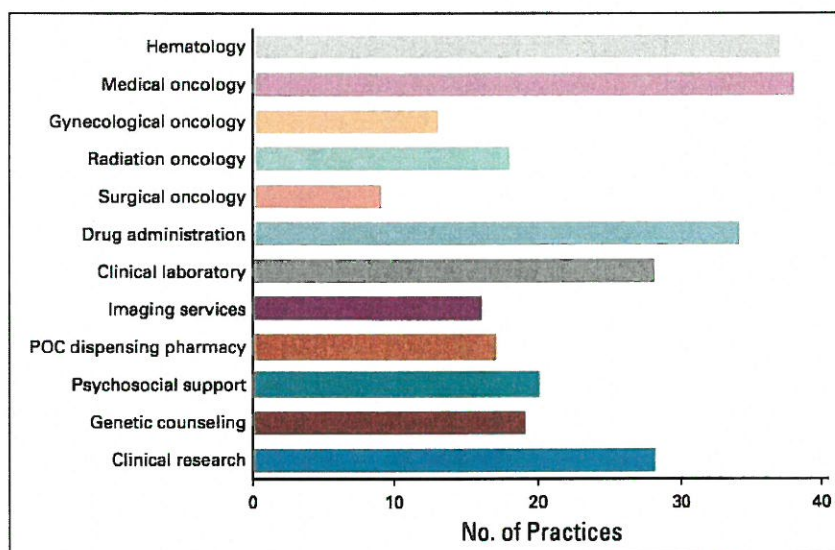


FIG 2. Number of practices (n = 38) offering specific services among full-time equivalent (FTE) physicians (n = 637.6). POC, point of care.

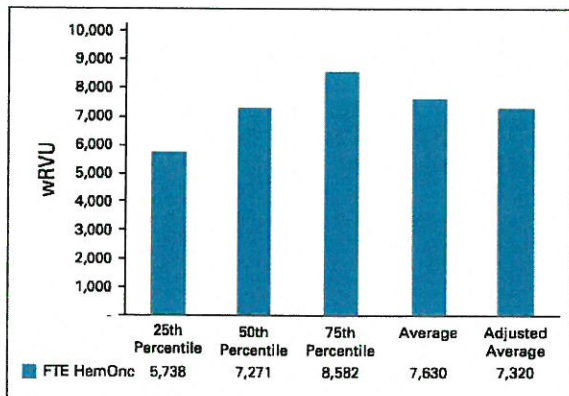


FIG 3. Work relative value units per full-time equivalent hematologist/oncologist (FTE HemOnc, n = 466) in 38 practices.

Practices reported an average of 12.3 hematologist/oncologists (Fig A1, online only) and, for those with radiation oncology services, an average of 5.8 radiation oncologists (Appendix Fig A2, online only). Respondents reported a variety of core and ancillary services offered by their practice (Fig 2).

Physician Productivity

The number of wRVUs reported per hematologist/oncologist is a principal productivity measure within the benchmark results. Within the resource-based relative value scale, each professional service is assigned a relative value unit for physician work (wRVU), practice expense, and professional liability insurance.² Health care organizations subscribe to these values—the Centers for Medicare & Medicaid Services publishes current amounts at least once per quarter—to calculate total wRVUs for compensation and other purposes.

Within the 38 responses successfully reporting productivity information for hematology/oncology, the interquartile range was 5,738 to 8,582 wRVUs, with an average of 7,320 per hematologist/oncologist (Fig 3). We did observe a difference in productivity levels on the basis of the reported practice type. Physician-owned practices reported an average of 7,673 wRVUs, whereas nonacademic hospital-owned practices reported an average of 7,123 wRVUs, all per FTE HemOnc.

Well-correlated to the overall level of wRVU-based productivity are the number of new patient/consult visits and established patient visits reported by participants. In this year's survey, the average of new patient/consult visits totaled 301 visits per FTE (Fig 4), whereas established patient visits (office visits for patients having previously been seen by the practice) had an average of 3,334 (Fig 5). We have observed that within our PracticeNET benchmarking collaborative, practices with higher performance in new patient/consult visits relative to average wRVUs experience future growth in overall productivity, whereas those with lower new patient/consult visits may experience future decline in overall productivity.

Although overall wRVUs were correlated to the number of visits, they were also influenced by differences in the levels of service reported for each visit type; each level of service is assigned a different wRVU value on the basis of the estimated time and complexity involved. Levels of service varied from practice to practice (Figs 6 and 7); for example, within new patient visits, the proportion of level five visits (99205) ranged from 2% to 89% of all new patient visits. Other visit measures include the number and distribution of hospital visits (including consults; Appendix Fig A3, online only), distribution of hospital visit levels of service (Appendix Figs A4 and A5, online only), and total number of

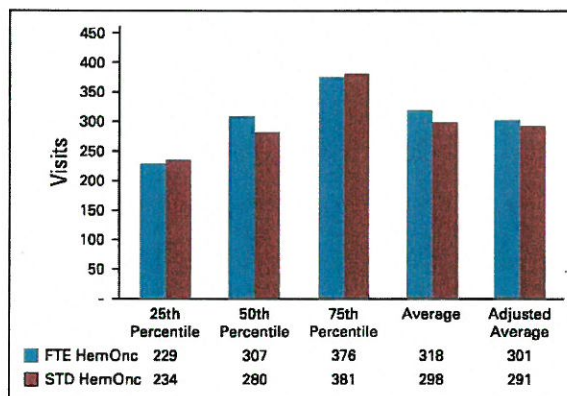


FIG 4. New patient/consult visits per hematologist/oncologist (HemOnc, n = 466) for billing codes 99201-99205, 99241-99245, and 99251-99255 in 38 practices. FTE, full-time equivalent; STD, standardized.

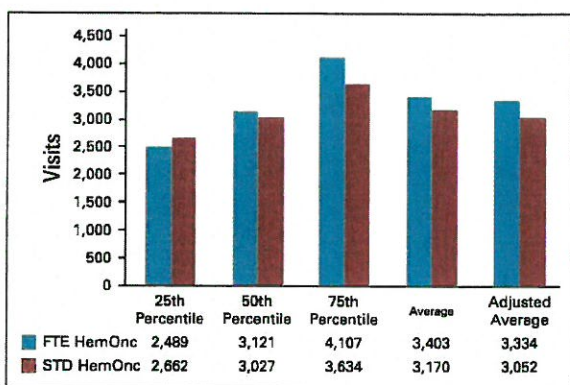


FIG 5. Established patient visits per hematologist/oncologist (HemOnc, n = 466) for billing codes 99211-99215 in 38 practices; FTE, full-time equivalent; STD, standardized.

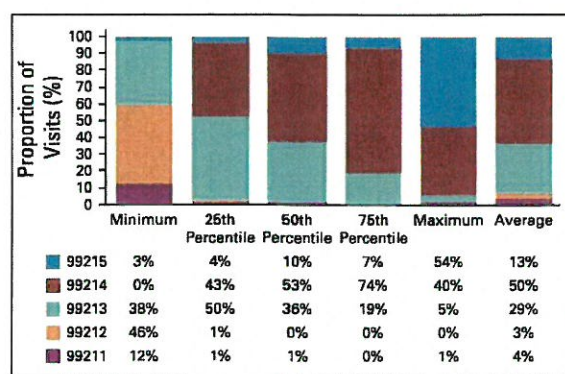


FIG 7. Level-of-service distribution among established patient visits for billing codes 99211-99215 in 38 practices; full-time equivalent hematologist/oncologists (n = 466).

evaluation and management visits per hematologist/oncologist (Appendix Fig A6, online only).

Within radiation oncology, respondents reported markedly higher number of wRVUs per radiation oncologist, with an average of 11,955 (Fig 8). Radiation oncologists averaged 204 new patient/consult visits for the year (Fig 9). Rather than reporting established patient visits, many of which are bundled into a 90-day global billing period for radiation oncology, we have included a benchmark for the number of radiation management services, with an average of 954 (Appendix Fig A7, online only). Although the wRVU and new patient/consult visit measures are used for both hematology/oncology and radiation oncology, we draw no conclusions about the differing productivity levels and caution against such comparisons among specialties.

Staffing and Equipment

Hematology/oncology staffing benchmarks are primarily described as the number of FTE staff per standardized hematologist/oncologist, a method that allows for adjustment

due to differing physician productivity levels. Twenty-nine of the 38 total survey responses included staff FTEs for hematology/oncology. Staffing measures were handled using the following rules:

- Responses that failed to include staffing information were excluded from all staffing measures.
- Responses that indicated that the practice did not provide certain services were excluded in applicable measures. For example, if a practice indicated that they did not provide clinical research, they were excluded from the research nurse measure.

Staffing measures are organized into clinical support of the hematologist/oncologist (Fig 10; Appendix Figs A8-A10, online only), drug administration (Figs 11-13; Appendix Figs A11-A17, online only), radiation oncology (Figs 14-16; Appendix Figs A18-A25, online only), other ancillary services (Appendix Figs A26-A30, online only), and administrative staff (Appendix Figs A31-A38, online only). We report the number of clinical staff assisting the hematologist/oncologist in patient evaluation and care management,

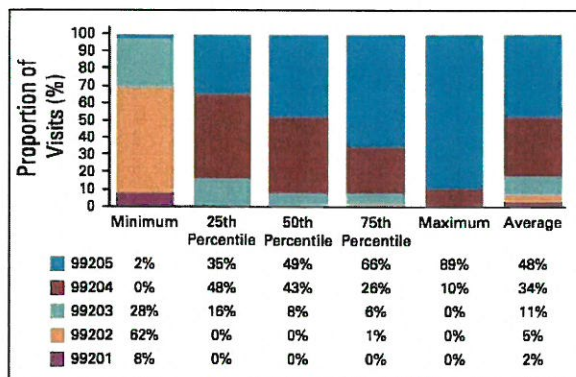


FIG 6. Level-of-service distribution among new patient visits for billing codes 99201-99205 in 38 practices; full-time equivalent hematologist/oncologists (n = 466).

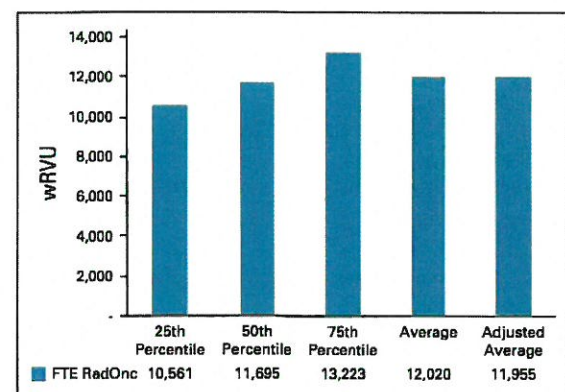


FIG 8. Work relative value units (wRVU) per radiation oncologist (RadOnc, n = 44.8) in 10 practices. FTE, full-time equivalent.

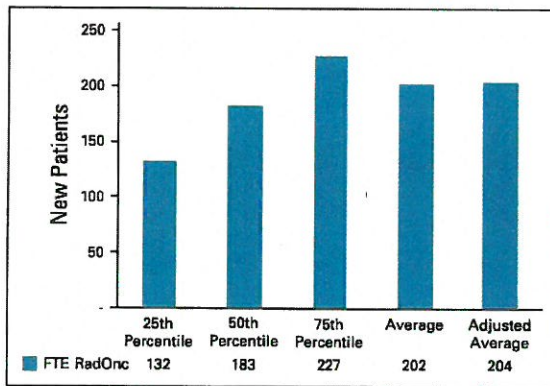


FIG 9. New patient/consult visits per full-time equivalent radiation oncologist (FTE RadOnc, $n = 44.8$) for billing codes 99201-99205, and 99241-99245 in 10 practices.

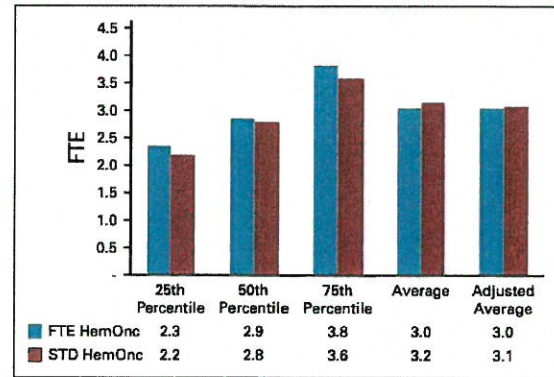


FIG 11. Drug administration staff per hematologist/oncologist (HemOnc, $n = 310.5$) in 21 practices. FTE, full-time equivalent; STD, standardized.

advanced practice providers (APPs; average per STD HemOnc, 0.7; Fig 10), nurses (other than drug administration; 0.6; Appendix Fig A8), and medical assistants (1.4; Appendix Fig A9). Less-often reported positions included social workers (present in 14 practices; < 0.1 -0.7 per STD HemOnc), genetic counselors (9 practices; < 0.1 -0.3), nutritionists (7 practices; < 0.1 -0.3), and other clinical support (15 practices; < 0.1 -1.1). At an average salary of \$108,809, APPs represented a significant investment for practices. Few responses included productivity information for this position; those who did averaged 2,027 wRVUs per APP (Appendix Fig A10).

Drug administration staff represented the second highest category of staffing expense, with an average of 3.1 FTE per STD HemOnc (Fig 11). Such positions included nurses (average per STD HemOnc, 2.2), pharmacists and technicians (0.6), and other drug administration staff (0.2; Appendix Fig A11). Respondents also reported their number of drug administration chairs, which averaged 5.9

chairs per STD HemOnc (Fig 12). The ratio of drug administration staff to chair averaged 0.5, the inverse of which is 2 chairs per drug administration staff (Appendix Fig A12).

Productivity of the drug administration unit is reported in this year's survey in a number of benchmarks. Benchmarks include the number of initial intravenous infusions/injections and total number of drug administration services per STD HemOnc (1,496 and 5,703, respectively; Appendix Figs A13 and A14), per drug administration staff (538 and 2,075; Appendix Figs A15 and A16), and per chair (264 and 1,052; Fig 13 and Appendix Fig A17).

Similar measures are reported for radiation oncology. Total clinical support staff averaged 5.9 FTE per radiation oncologist (Fig 14), made up of 0.9 nurses (Appendix Fig A18), 0.3 medical assistants (Appendix Fig A19), 2.8 radiation therapists (Appendix Fig A20), and 1.6 physics staff (Appendix Fig A21), equally divided between physicists and dosimetrists. Radiation-specific APPs were reported by only one practice.

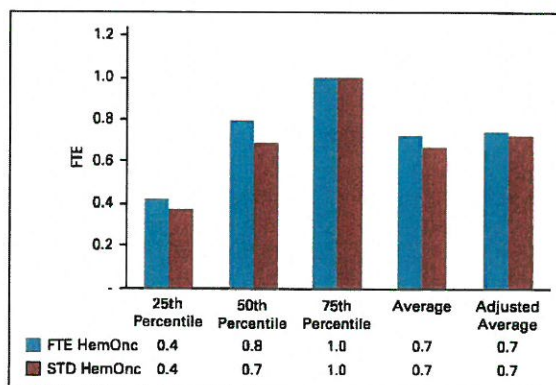


FIG 10. Hematology/oncology advanced practice providers per hematologist/oncologist (HemOnc, $n = 364.3$) in 29 practices. FTE, full-time equivalent.

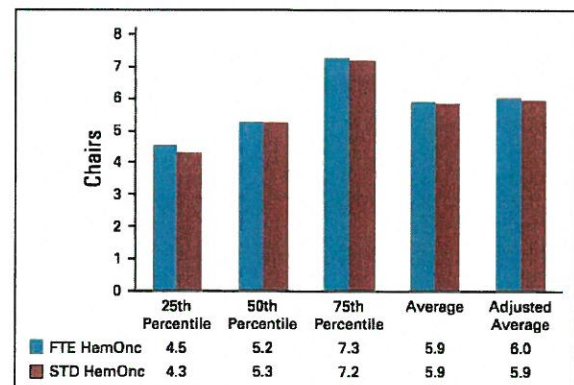


FIG 12. Drug administration chairs per hematologist/oncologist (HemOnc, $n = 310.5$) in 21 practices. FTE, full-time equivalent; STD, standardized.

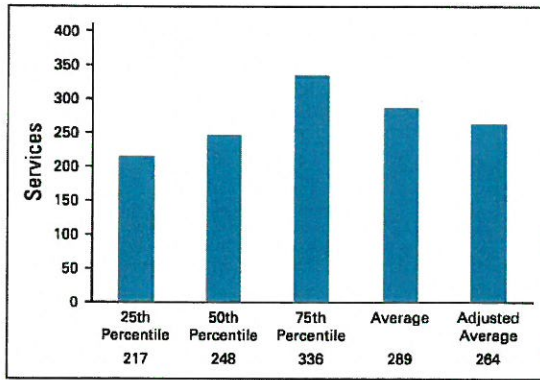


FIG 13. Initial intravenous infusion services per drug administration chair for billing codes 96360, 96365, 96374, 96409, and 96413 in 21 practices. Full-time equivalent hematologist/oncologists ($n = 310.5$).

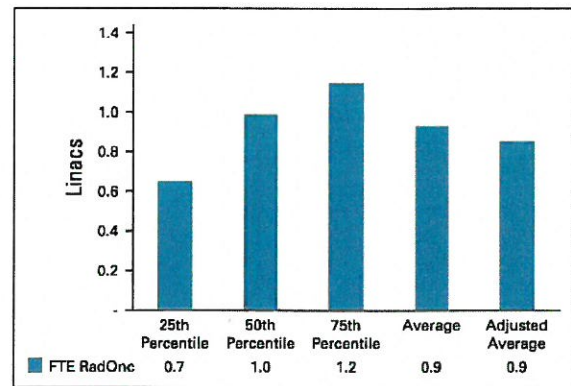


FIG 15. Linear accelerators (Linacs) per full-time equivalent radiation oncologist (FTE RadOnc, $n = 32.8$) in 7 practices.

Linear accelerators and their associated equipment present a high fixed cost for radiation oncology, with an average investment of \$4.1 million (calculated from equipment expense survey data assigned to radiation treatment procedures³). An average of 0.9 linear accelerators were reported per FTE radiation oncologist (Fig 15), staffed by 3.3 radiation therapists each (Appendix Fig A22). The number of annual external beam radiation treatments (EBRT) per linear accelerator had an interquartile range of 4,002–7,213, with an average of 5,237 (Fig 16). EBRT is also reported per FTE radiation oncologist (4,197; Appendix Fig A23) and FTE radiation therapist (1,578; Appendix Fig A24). EBRT was reported for multiple treatment modalities, including conventional/conformal treatments (45.9%), intensity-modulated radiation treatments (51.6%), stereotactic body radiation therapy (2.4%), and stereotactic radiosurgery (0.1%; Appendix Fig A25).

Ancillary staffing included in this year's survey include clinical laboratory staff (0.6 per FTE physician; Appendix Fig A26), imaging staff (0.3; Appendix Fig A27), and

point-of-care dispensing pharmacy staff (0.3; Appendix Fig A28). Clinical research staff ranged from 0.4–0.8 per physician (interquartile), with an average of 0.6 per FTE physician (Appendix Fig A29); these measures are also reported by FTE HemOnc and STD HemOnc. Research staff consisted of research nurses (0.2 per FTE physician), data managers (0.3), and administrative staff (0.1; Appendix Fig A30). Although the staffing measures reflect a meaningful cost to ancillary services, other costs, such as laboratory reagents and imaging equipment, were not surveyed.

Administrative staff averaged 3.3 FTE per physician (Appendix Fig A31), the largest category of which was front desk (1.0; Appendix Fig A32) and billing staff (1.3; Appendix Fig A33). Within the billing staff, special attention is paid to financial advocates charged with addressing patient out-of-pocket expenses (0.2 per FTE physician; Appendix Fig A34) and staff responsible for managed care authorization of diagnostic and therapeutic orders (0.3 average; Appendix Fig A35). The productivity of billing staff is also reported as annual collections per FTE billing staff

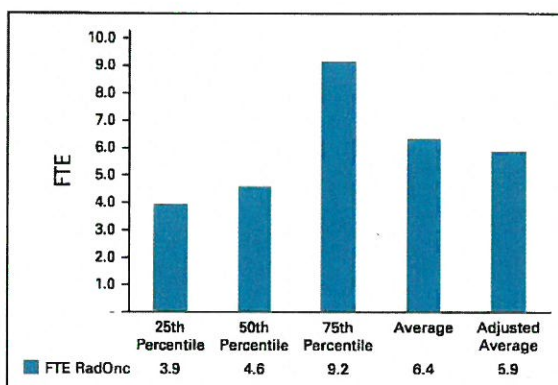


FIG 14. Clinical support staff per full-time equivalent radiation oncologist (FTE RadOnc, $n = 32.8$) in 7 practices.

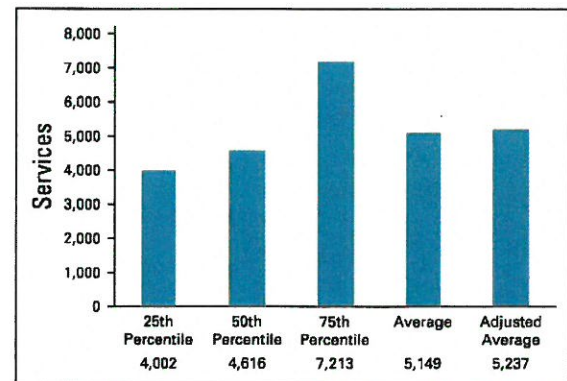


FIG 16. External beam radiation treatments per linear accelerator in 7 practices; full-time equivalent radiation oncologists (FTE RadOnc, $n = 32.8$).

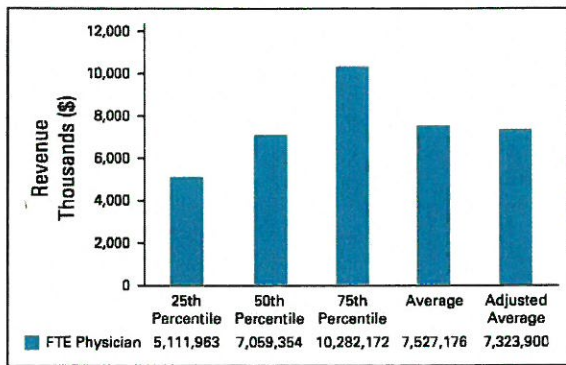


FIG 17. Total practice revenue per full-time equivalent (FTE) physician (n = 374.8) in 18 practices.

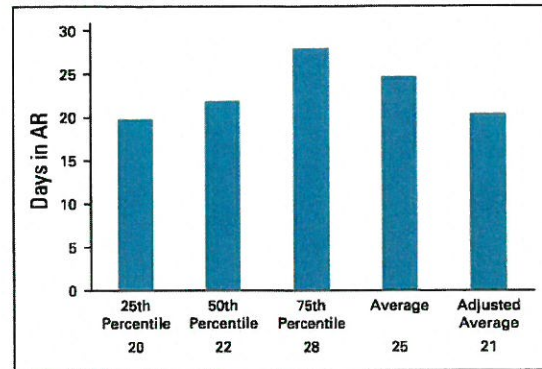


FIG 19. Year-end business days of revenue in accounts receivable (AR) in 14 practices; full-time equivalent physicians (n = 297.4).

(\$5,404,174; Appendix Fig A36). Other administrative positions include executive staff (0.2 per FTE physician; Appendix Fig A37), other managers (0.3; Appendix Fig A38), and other administrative support (0.7).

Revenue and Expenses

Total revenue and expense (including physician salaries) per FTE physician are reported in the survey (\$7,323,900 and \$7,261,026, respectively; Figs 17 and 18), though differing services per practice make comparison difficult. Therefore, we have presented these measures per service category to allow readers to use measures meaningful to their practice setting. Evaluation and management revenue within hematology/oncology averaged \$487,251 per STD HemOnc (Appendix Fig A39, online only). Drug administration revenue averaged \$391,626 (Appendix Fig A40, online only), set against direct staffing expense of \$188,397 (Appendix Fig A41, online only) and supply expense of \$72,906 per STD HemOnc (Appendix Fig A42, online only). Drug revenue, before accounting for cost of goods sold (drug cost), averaged \$5,709,846 per STD HemOnc (Appendix Fig A43, online only) and has been increasing over the past 3 years within the ASCO PracticeNET

program. Drug expense for administered drugs averaged \$5,121,744 (Appendix Fig A44, online only), with drug revenue net of expense averaging \$982,079 per STD HemOnc (Appendix Fig A45, online only).

Radiation revenue represented a significant nondrug revenue source for practices with radiation oncology services, averaging \$2,967,442 per FTE radiation oncologist (Appendix Fig A46, online only), with an average of \$584,128 per radiation oncologist in staff expense (Appendix Fig A47, online only).

Within ancillary services, clinical laboratory revenue averaged \$103,639 (Appendix Fig A48, online only), against \$29,805 in staffing expense per FTE physician (Appendix Fig A49, online only); imaging revenue averaged \$190,500 (Appendix Fig A50, online only), with \$35,399 in staffing expense per FTE physician (Appendix Fig A51, online only). Point-of-care dispensing pharmacy revenue averaged \$1,843,342 (Appendix Fig A52, online only), with drug expense of \$1,685,257 (Appendix Fig A53, online only), revenue net of drug expense of \$157,084 (Appendix Fig A54, online only), and staffing expense of \$21,098 per FTE physician (Appendix Fig A55, online only). Practices with clinical

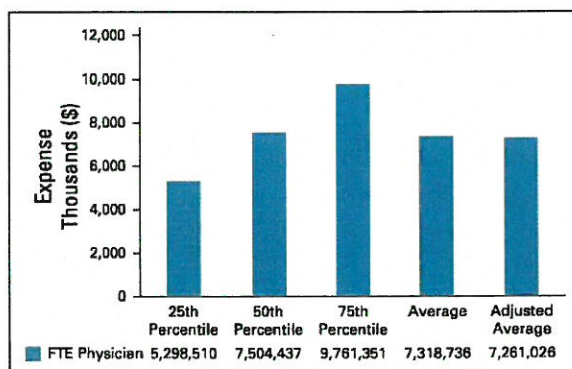


FIG 18. Total practice expense per full-time equivalent (FTE) physician (n = 353.7) in 16 practices.

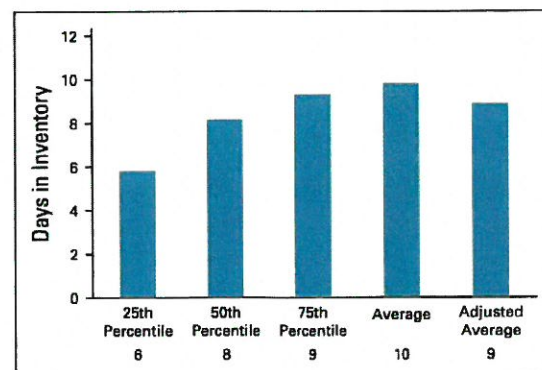


FIG 20. Year-end business days of drug revenue in inventory in 15 practices full-time equivalent hematologist/oncologists (n = 239.1).

TABLE 2. Salary Results

Position (No. practices)	25th Percentile	50th Percentile	75th Percentile	Average	Adjusted Average
Advanced practice provider (medical; 23)	94,892	110,169	119,216	108,807	108,809
Nurse navigator/clinician (medical; 11)	61,763	69,575	84,947	71,677	71,578
Medical assistant (medical; 25)	31,387	36,201	43,884	38,500	37,301
Social worker (13)	57,744	64,401	82,513	70,141	71,647
Genetic counselor (7)	75,058	85,476	100,889	90,179	84,038
Nutritionist (6)	50,575	57,716	75,010	61,404	62,521
Drug administration, nurse (18)	62,409	77,051	89,120	76,090	75,000
Drug administration, pharmacy (20)	52,969	66,805	95,890	78,988	77,449
Drug administration, other (11)	32,791	45,464	53,437	53,122	50,480
Nurse navigator/clinician (radiation; 7)	56,887	61,842	74,203	63,039	63,580
Medical assistant (radiation; 5)	21,506	32,619	40,535	31,340	32,928
Radiation therapist (8)	73,866	77,954	83,535	83,009	83,431
Medical physicist (7)	193,818	206,276	231,062	209,716	209,672
Dosimetrist (7)	98,781	101,307	131,742	114,148	115,263
Laboratory staff (18)	44,242	55,289	62,326	54,197	52,139
Imaging staff (6)	73,806	80,627	92,949	81,842	76,488
Point-of-care pharmacy, pharmacist (9)	105,835	127,278	137,950	124,584	122,578
Point-of-care pharmacy, other (7)	37,033	38,351	47,098	45,938	43,240
Clinical research, nurse (10)	62,743	71,588	95,174	76,993	77,582
Clinical research, data management (14)	46,984	50,000	56,851	56,022	51,855
Clinical research, administration (14)	52,337	58,594	74,506	69,047	67,122
Executive (18)	139,849	175,786	297,597	230,667	242,055
Other managers (20)	62,102	87,394	98,071	81,778	80,986
Front desk (24)	30,917	35,192	42,775	37,103	37,779
Financial advocate (20)	37,648	42,022	48,038	42,219	42,613
Authorization (5)	17,156	29,600	68,312	40,107	33,586
Other billing staff (22)	39,653	43,177	52,129	45,015	44,523

NOTE. Data given in \$.

research units reported an average revenue of \$49,140 (Appendix Fig A56, online only) and staffing expense of \$30,103 per FTE physician (Appendix Fig A57, online only).

Key overhead expenses included administrative staff expense of \$185,776 (Appendix Fig A58, online only), direct information technology expense of \$52,675 (Appendix Fig A59, online only), and facility expense of \$169,902 per FTE physician (Appendix Fig A60, online only). Practices reported carrying costs of \$632,483 in accounts receivable (21 business days; Fig 19; Appendix Fig A61, online only) and \$191,688 in drug inventory per FTE physician at the end of 2018 (9 business days; Fig 20; Appendix Fig A62, online only).

Salary Survey

Table 2 includes salary results for 27 oncology positions for which ASCO has received at least five responses for wages and FTE staff. In some positions we have found high

variation in rates—drug administration pharmacy staff had an interquartile difference of \$42,921—which may be indicative of poor definition in the associated questions. These questions have been flagged for refinement in future surveys.

In conclusion, the SOPO provides oncology practices in all practice settings with an important and unique tool to measure their operations. This year's results are a much-needed update to the literature. We intend to repeat this survey annually to provide additional practices an opportunity to participate and to provide the community current benchmarks and trends. Continuation of the survey will also provide an opportunity to explore additional metrics and analyses on the basis of these results and community feedback.

The 62% of practice responses not accepted are demonstrative of the difficulty in gathering key data on oncology practice operations. These practices may benefit

from participation in ASCO's PracticeNET program, which provides practices numerous productivity, revenue, and value-based care measures on a quarterly basis. We

encourage all practices to consider how they measure their operations and identify meaningful benchmarks to support goal setting and improvement activities.

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AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST AND DATA AVAILABILITY STATEMENT

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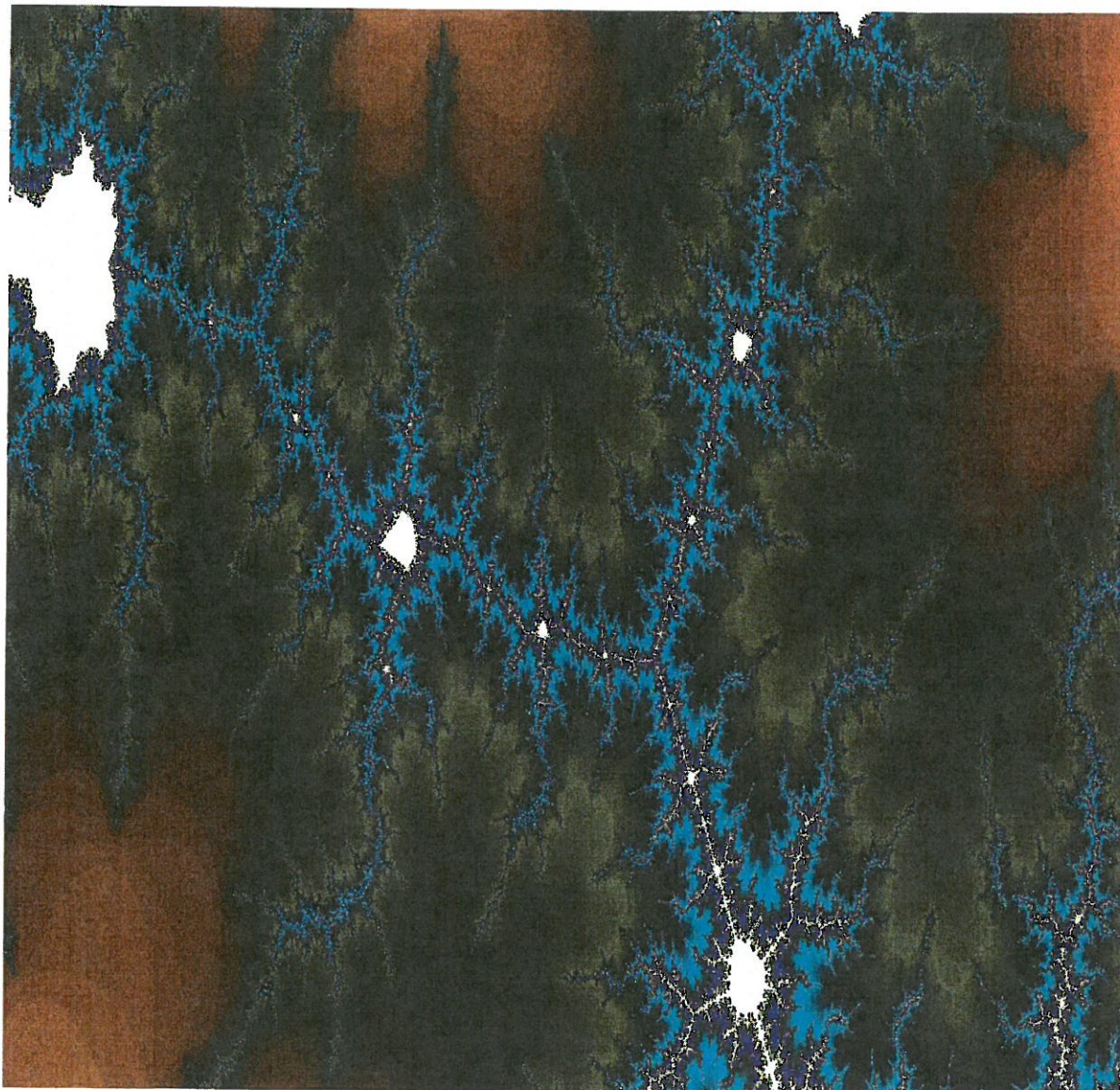
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Radiation Therapy Staffing and Workplace Survey 2022



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American Society of Radiologic Technologists

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Executive Summary

The 2022 Radiation Therapy Staffing and Workplace Survey was emailed to 14,520 radiation therapists in June 2022. At the close of the survey in July 2022, a total of 629 completed questionnaires had been submitted for a response rate of 4.3%

The sample size of 629 yields a margin of error for overall percentages of $\pm 3.9\%$ at the 95% confidence interval.

To keep this report brief, responses to open-ended questions were not included, but are available upon request.

Staffing of Facilities

The mean number of budgeted full-time equivalents (FTEs) across all facilities surveyed is:

- 7.3 for radiation therapy.
- 2.4 for medical dosimetry.

An estimation of the overall percentages of unfilled positions was calculated using the number of budgeted FTEs along with figures on vacant and recruiting positions.

In radiation therapy, an estimated 10.7% of FTE positions are unfilled.

In medical dosimetry, an estimated 11.3% of FTE positions are unfilled.

Overall mean percentages of unfilled positions, calculated by combining the figures from both therapy and dosimetry, were highest in the Middle Atlantic region (15.8%) and lowest in the West North Central region (6.2%). Overall, the percent of unfilled positions combining both disciplines was 11.0%.

The survey also tracks longitudinal changes in staffing levels in radiation therapy and medical dosimetry. The number of FTE radiation therapists budgeted at each facility rose by 0.2 from 7.1 to 7.3 between 2020, when the last Radiation Therapy Staffing Survey was conducted, and 2022. Overall, the number of FTE therapists budgeted per facility has increased by 1.3 from 6.0 in 2004 to 7.3 in 2022.

The number of FTE dosimetrists budgeted per facility fell slightly by 0.1 from 2.5 in 2020 to 2.4 in 2022. Overall, the number of FTE dosimetrists budgeted per facility has increased by 0.8 from 1.6 in 2004 to 2.4 in 2022.

- The estimated vacancy rate for FTE positions in therapy rose by 3.5%, from 7.2% in 2020 to 10.7% in 2022. This marks the fourth consecutive rise in vacancy rates registered by the survey.
- The estimated vacancy rate for FTE positions in medical dosimetry rose by 1.8%, from 9.6% in 2020 to 11.4% in 2022. This marks the second consecutive survey in which vacancy rates in dosimetry have risen.

Facility Demographics

A slim majority of respondents (51.4%) are staff therapists; 19.6% are senior/lead therapists, 7.8% are supervisors/managers, and 6.5% are medical dosimetrists.

There were respondents from every state.

Urban facilities represented the largest share (44.0%) of respondents; 41.0% were suburban, and the remaining 15.0% were rural.

The average respondent to the survey works in a facility that offers 14.2 services in radiation therapy and related fields. The most commonly offered services are:

- Intensity-modulated radiation therapy (IMRT) (96.6% of facilities).
- CT/simulation (94.8% of facilities).
- Cone-beam CT (CBCT) (93.5% of facilities).

The most commonly offered services remained the same from the previous survey in 2020, albeit with minor changes in position.

The least commonly offered services are:

- Hyperthermia (4.2% of facilities).
- Proton therapy (6.4% of facilities).
- Ultrasound localization (8.5% of facilities).

When asked which, if any, services they plan to expand, 55.6% of respondents said they plan to add additional LINAC therapy units, 16.5% plan to add real-time

surface tracking, and another 16.5% plan to add adaptive planning; 33.4% have no plans to add any of the new services listed.

According to the responses provided, the average facility treats 50.1 patients each day and uses 2.2 linear accelerators.

Personnel Demographics

The average respondent works at a facility that schedules 2.4 therapists and 1.1 dosimetrist per linear accelerator. On average, there are 1.2 hours per day when only one therapist is scheduled per linear accelerator.

Calculation of Percent Vacancy Rates

The estimated proportion of unfilled positions for a given specialty in the population of U.S. hospital-based radiology facilities is calculated as:

$$(\text{mean number of vacant and recruiting FTEs per facility}) / (\text{mean number of budgeted FTEs per facility}) * 100$$

For example, in radiation therapy the mean vacant and recruiting FTE positions per facility is 0.78. When divided by the mean budgeted FTE of 7.3, this yields a proportion of unfilled FTE positions of 0.107. Multiplying by 100 to give the percent value, and then rounding to the nearest tenth, gives the percent vacancy rate for radiation therapy of 10.7%.

Note that only responses that included both the number of budgeted FTEs and the number of vacant and recruiting FTEs were used in the calculation of vacancy rates.

Outliers

Numeric variables were analyzed for non-representative outliers with cross-tabulated scatter plots and box plots. Numeric data points that were 3 times greater than the interquartile range were designated as outliers and excluded from the analysis.

Staffing of Facilities

Provide the budgeted and vacant full-time equivalents (FTEs) for your facility. Please use decimals for fractional FTEs.

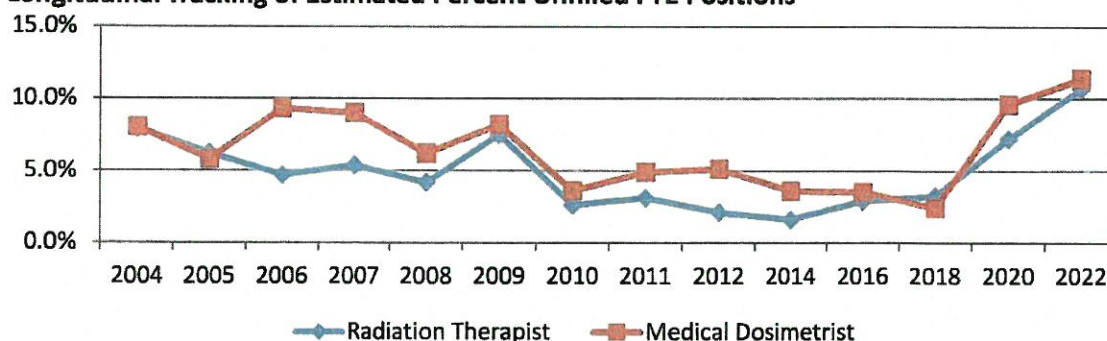
Radiation Therapist

Year	N	Mean budgeted FTEs per facility	Mean vacant and recruiting FTEs per facility	Estimated percent unfilled FTE positions
2004	360	6.0	0.47	7.9%
2005	352	6.4	0.40	6.2%
2006	522	6.8	0.31	4.7%
2007	549	7.1	0.39	5.4%
2008	476	6.8	0.29	4.2%
2009	448	7.2	0.54	7.5%
2010	484	7.2	0.19	2.6%
2011	460	7.4	0.23	3.1%
2012	439	7.4	0.16	2.1%
2014	575	8.2	0.13	1.6%
2016	552	7.3	0.21	2.9%
2018	124	7.7	0.25	3.2%
2020	517	7.1	0.51	7.2%
2022	573	7.3	0.78	10.7%

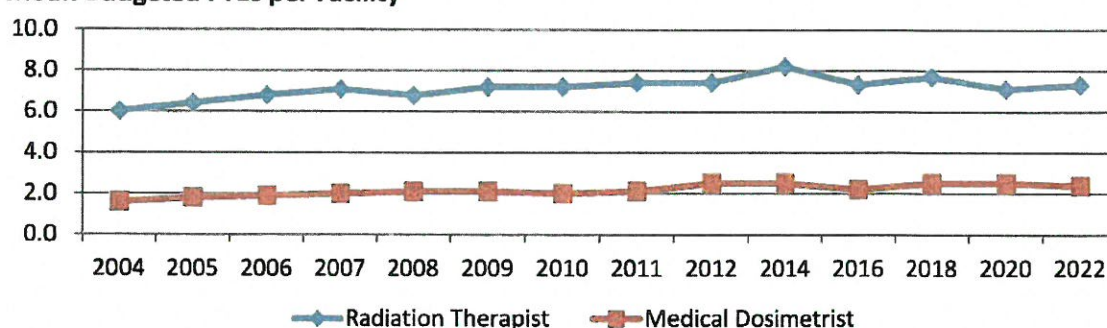
Medical Dosimetrist

Year	N	Mean budgeted FTEs per facility	Mean vacant and recruiting FTEs per facility	Estimated percent unfilled FTE positions
2004	360	1.6	0.13	8.0%
2005	352	1.8	0.11	5.8%
2006	522	1.9	0.18	9.3%
2007	549	2.0	0.18	9.0%
2008	441	2.1	0.13	6.2%
2009	409	2.1	0.17	8.2%
2010	432	2.0	0.07	3.6%
2011	411	2.1	0.10	4.9%
2012	406	2.5	0.12	5.1%
2014	544	2.5	0.09	3.6%
2016	517	2.2	0.08	3.5%
2018	117	2.5	0.06	2.4%
2020	447	2.5	0.24	9.6%
2022	509	2.4	0.27	11.4%

Longitudinal Tracking of Estimated Percent Unfilled FTE Positions



Mean Budgeted FTEs per Facility



2022 Estimated Percent of Unfilled FTE Positions by Geographic Region^a

		Middle Atlantic	Pacific	East South Central	South Atlantic	Mountain	West South Central	East North Central	New England	West North Central
Radiation Therapy	N	37	71	27	117	95	57	87	41	40
	%	15.3%	14.9%	12.7%	10.4%	10.2%	9.6%	9.6%	9.0%	6.3%
Medical Dosimetry	N	33	63	28	109	79	50	76	34	36
	%	16.4%	8.2%	9.0%	11.5%	11.6%	11.7%	9.2%	22.0%	6.0%
Overall Mean		15.8%	11.7%	10.8%	10.9%	10.9%	10.6%	9.4%	14.9%	6.2%

^a Middle Atlantic: New York, Pennsylvania, and New Jersey

Pacific: Alaska, Washington, Oregon, California, and Hawaii

East South Central: Kentucky, Tennessee, Mississippi, and Alabama

South Atlantic: Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, and Florida

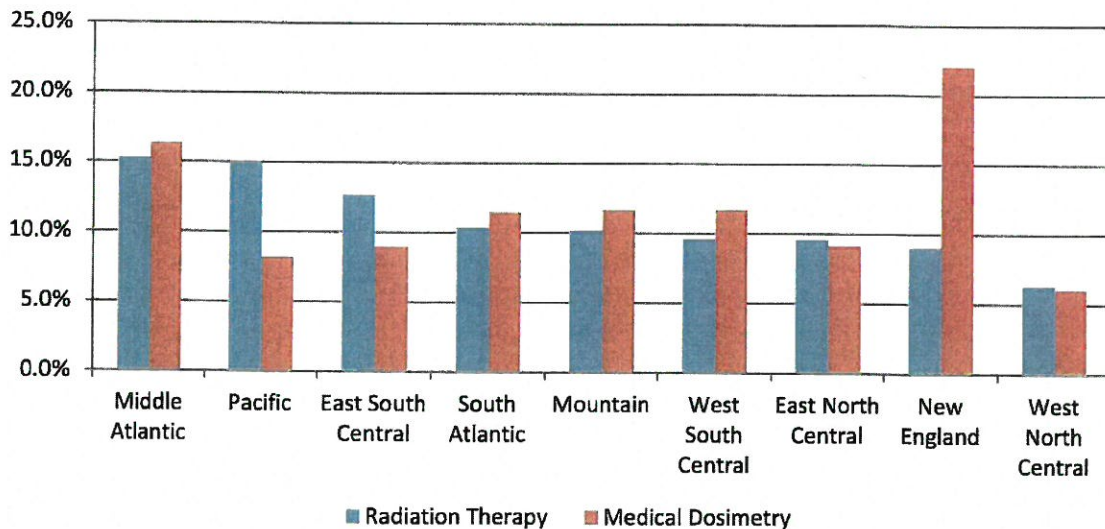
Mountain: Idaho, Montana, Wyoming, Nevada, Utah, Colorado, Arizona, and New Mexico

West South Central: Oklahoma, Texas, Arkansas, and Louisiana

East North Central: Wisconsin, Michigan, Illinois, Indiana, and Ohio

New England: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut

West North Central: Missouri, North Dakota, South Dakota, Nebraska, Kansas, Minnesota, and Iowa

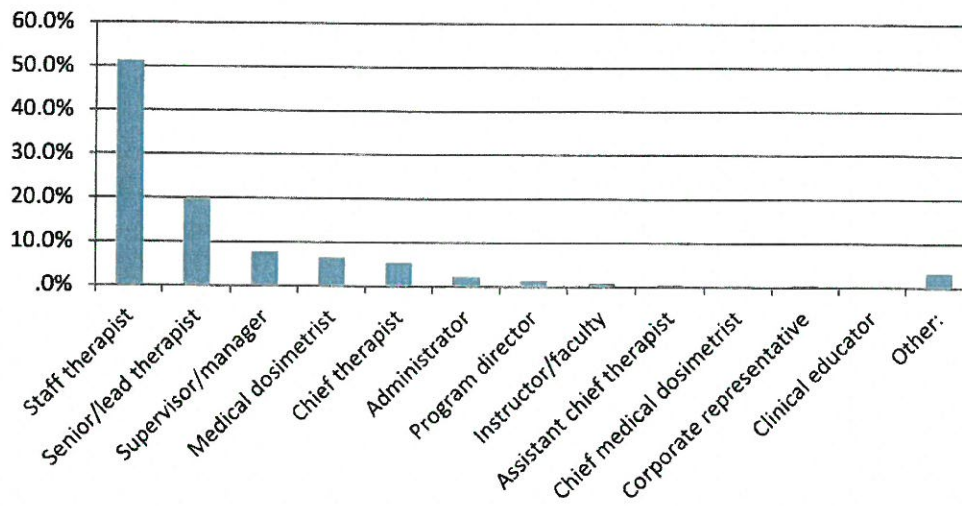
2022 Estimated Percent of Unfilled FTE Positions by Geographic Region

Facility Demographics

What is your primary job function?

	N	Valid Percent
Staff therapist	323	51.4%
Senior/lead therapist	123	19.6%
Supervisor/manager	49	7.8%
Medical dosimetrist	41	6.5%
Chief therapist	34	5.4%
Administrator	14	2.2%
Program director	9	1.4%
Instructor/faculty	5	0.8%
Assistant chief therapist	3	0.5%
Chief medical dosimetrist	3	0.5%
Corporate representative	3	0.5%
Clinical educator	1	0.2%
Other:	21	3.3%
Total	629	100.0%

What is your primary job function?

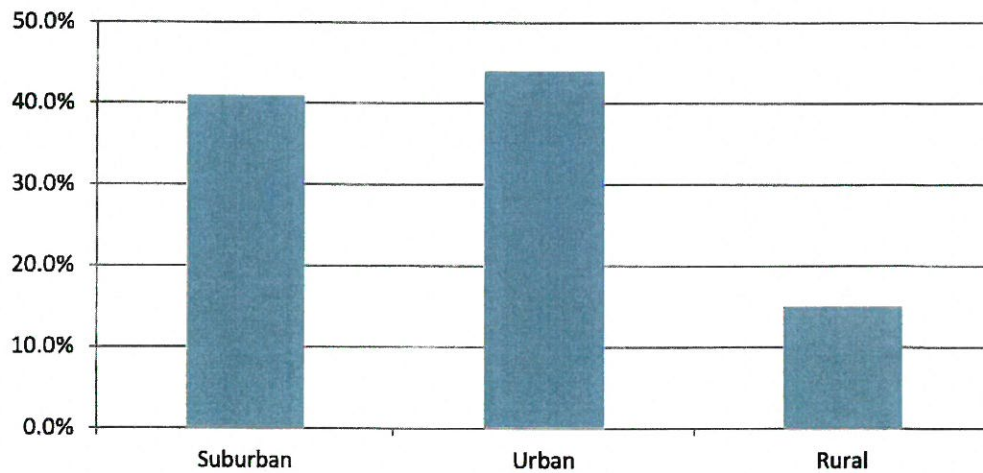


Responding Facilities by State

State	N	State	N	State	N	State	N	State	N
Alabama	7	Hawaii	2	Massachusetts	13	New Mexico	4	South Dakota	5
Alaska	2	Idaho	2	Michigan	31	New York	29	Tennessee	5
Arizona	16	Illinois	37	Minnesota	13	North Carolina	16	Texas	32
Arkansas	7	Indiana	23	Mississippi	6	North Dakota	2	Utah	5
California	47	Iowa	16	Missouri	11	Ohio	17	Vermont	4
Colorado	12	Kansas	8	Montana	1	Oklahoma	9	Virginia	27
Connecticut	12	Kentucky	14	Nebraska	9	Oregon	11	Washington	9
Delaware	1	Louisiana	7	Nevada	3	Pennsylvania	36	West Virginia	1
Florida	32	Maine	3	New Hampshire	6	Rhode Island	1	Wisconsin	23
Georgia	12	Maryland/DC	13	New Jersey	14	South Carolina	9	Wyoming	3

Location of Facility:

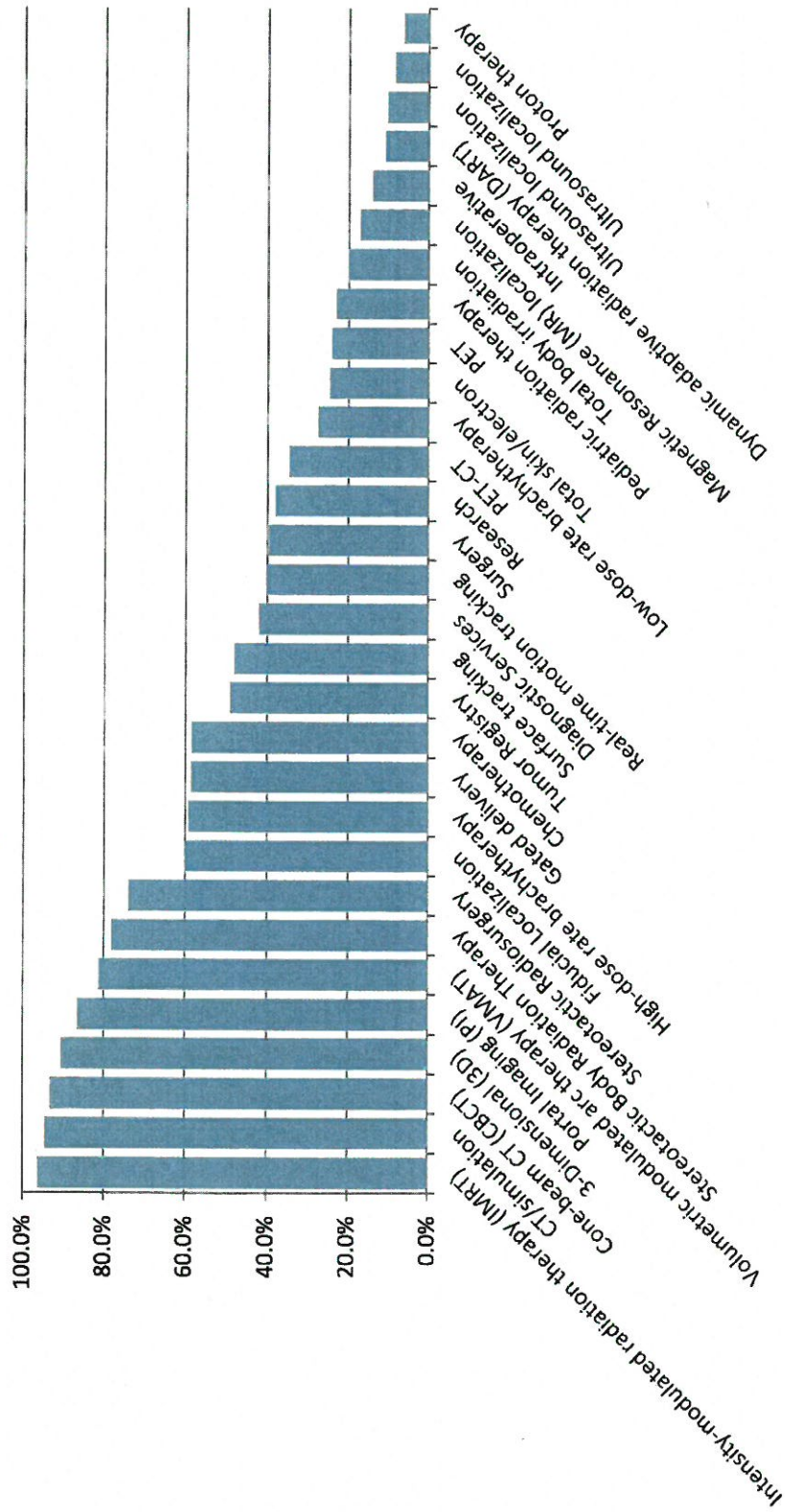
	N	Valid Percent
Suburban	256	41.0%
Urban	275	44.0%
Rural	94	15.0%
Total	625	100.0%

Location of Facility:

Which of the following services does your facility provide?

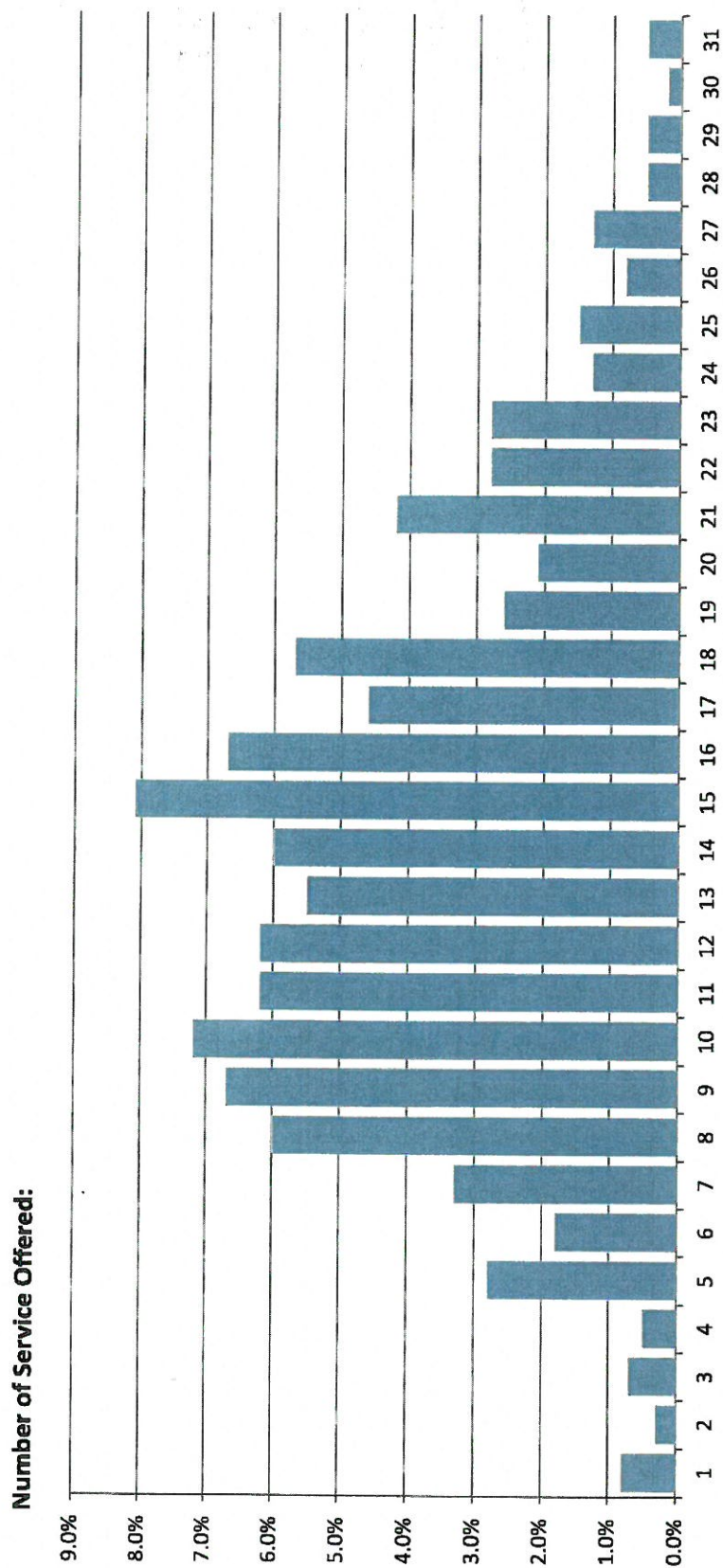
	N	Percent of Cases
Intensity-modulated radiation therapy (IMRT)	593	96.6%
CT/simulation	582	94.8%
Cone-beam CT (CBCT)	574	93.5%
3-Dimensional (3D)	557	90.7%
Portal Imaging (PI)	532	86.6%
Volumetric modulated arc therapy (VMAT)	500	81.4%
Stereotactic Body Radiation Therapy	480	78.2%
Stereotactic Radiosurgery	455	74.1%
Fiducial Localization	371	60.4%
High-dose rate brachytherapy	365	59.4%
Gated delivery	361	58.8%
Chemotherapy	360	58.6%
Tumor Registry	303	49.3%
Surface tracking	296	48.2%
Diagnostic Services	259	42.2%
Real-time motion tracking	248	40.4%
Surgery	245	39.9%
Research	234	38.1%
PET-CT	213	34.7%
Low-dose rate brachytherapy	170	27.7%
Total skin/electron	152	24.8%
PET	149	24.3%
Pediatric radiation therapy	142	23.1%
Total body irradiation	124	20.2%
Magnetic Resonance (MR) localization	106	17.3%
Intraoperative	87	14.2%
Dynamic adaptive radiation therapy (DART)	68	11.1%
Ultrasound localization	64	10.4%
Ultrasound localization	52	8.5%
Proton therapy	39	6.4%
Hyperthermia	26	4.2%

Which of the following services does your facility provide?



Number of Services Provided by Each Facility

	N	Valid Percent	Cumulative Percent
1	5	0.8%	0.8%
2	2	0.3%	1.1%
3	4	0.7%	1.8%
4	3	0.5%	2.3%
5	17	2.8%	5.0%
6	11	1.8%	6.8%
7	20	3.3%	10.1%
8	37	6.0%	16.1%
9	41	6.7%	22.8%
10	44	7.2%	30.0%
11	38	6.2%	36.2%
12	38	6.2%	42.3%
13	34	5.5%	47.9%
14	37	6.0%	53.9%
15	50	8.1%	62.1%
16	41	6.7%	68.7%
17	28	4.6%	73.3%
18	35	5.7%	79.0%
19	16	2.6%	81.6%
20	13	2.1%	83.7%
21	26	4.2%	87.9%
22	17	2.8%	90.7%
23	17	2.8%	93.5%
24	8	1.3%	94.8%
25	9	1.5%	96.3%
26	5	0.8%	97.1%
27	8	1.3%	98.4%
28	3	0.5%	98.9%
29	3	0.5%	99.3%
30	1	0.2%	99.5%
31	3	0.5%	100.0%
Total	614	100.00%	
Mean	14.2 (SD=5.8)		
Percentiles	5th=5.0, 25th=10.0, 50th=14.0 75th=18.0, 95th=25.0		

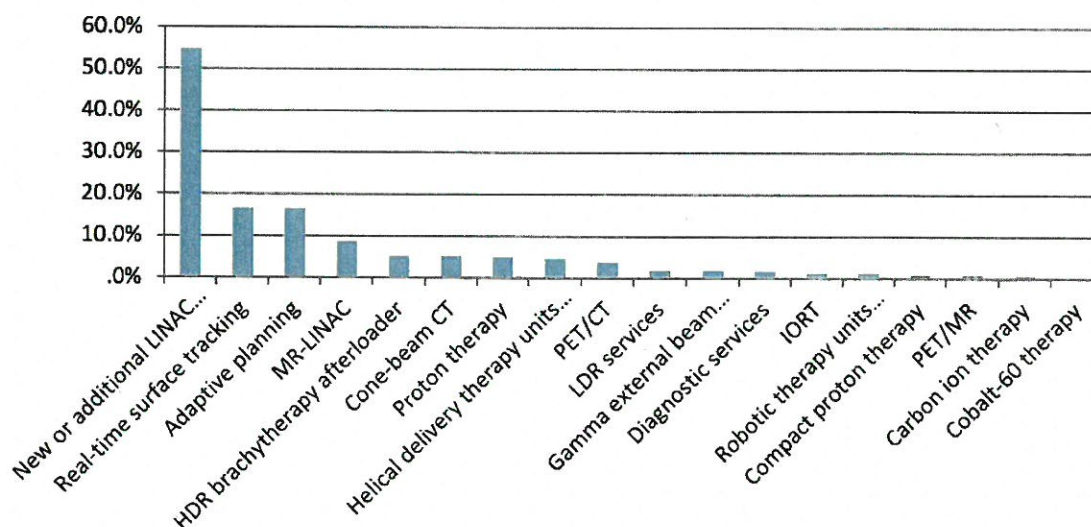


Over the next few years, is your facility planning to expand services to include any of the following?^a

	N	Percent of Cases
New or additional LINAC therapy units	327	54.6%
Real-time surface tracking	99	16.5%
Adaptive planning	99	16.5%
MR-LINAC	52	8.7%
HDR brachytherapy afterloader	31	5.2%
Cone-beam CT	31	5.2%
Proton therapy	30	5.0%
Helical delivery therapy units (TomoTherapy, Halcyon, etc.)	28	4.7%
PET/CT	23	3.8%
LDR services	11	1.8%
Gamma external beam therapy (GammaKnife, GammaPod, etc.)	11	1.8%
Diagnostic services	10	1.7%
IORT	8	1.3%
Robotic therapy units (CyberKnife)	7	1.2%
Compact proton therapy	5	.8%
PET/MR	5	.8%
Carbon ion therapy	4	0.7%
Cobalt-60 therapy	1	0.2%

^a 200 (33.4%) responded "None of the above".

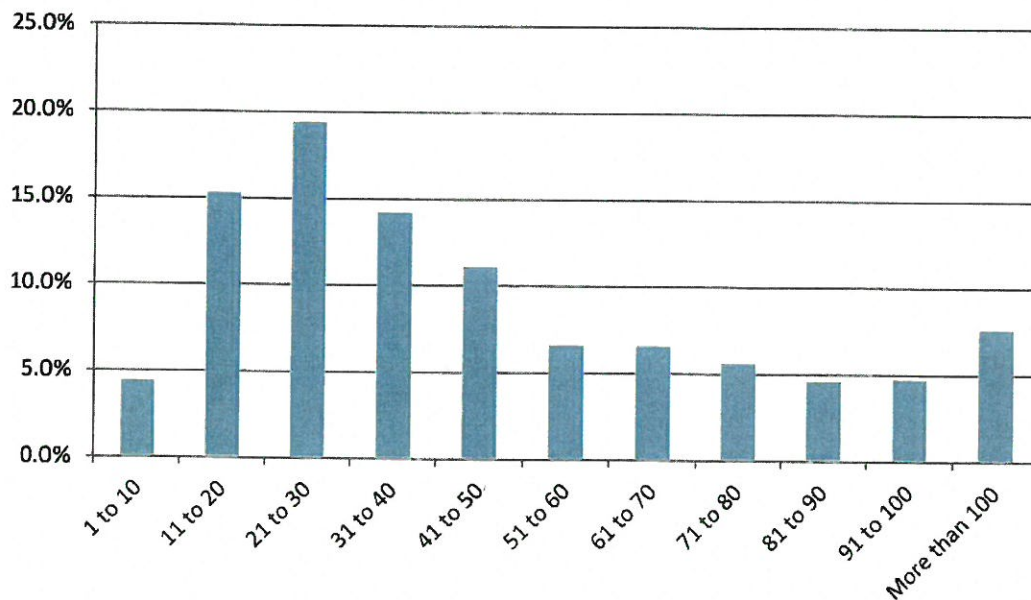
Over the next few years, is your facility planning to expand services to include any of the following?



On average, how many patients are treated daily at your facility?

	N	Valid Percent	Cumulative Percent
1 to 10	26	4.4%	4.4%
11 to 20	91	15.3%	19.7%
21 to 30	115	19.4%	39.1%
31 to 40	84	14.2%	53.3%
41 to 50	66	11.1%	64.4%
51 to 60	39	6.6%	71.0%
61 to 70	39	6.6%	77.6%
71 to 80	33	5.6%	83.1%
81 to 90	27	4.6%	87.7%
91 to 100	28	4.7%	92.4%
More than 100	45	7.6%	100.0%
Total	593	100.0%	
Mean	50.1 (SD=34.7)		
Percentiles	5th=12.0, 25th=25.0, 50th=40.0 75th=67.6, 95th=120.0		

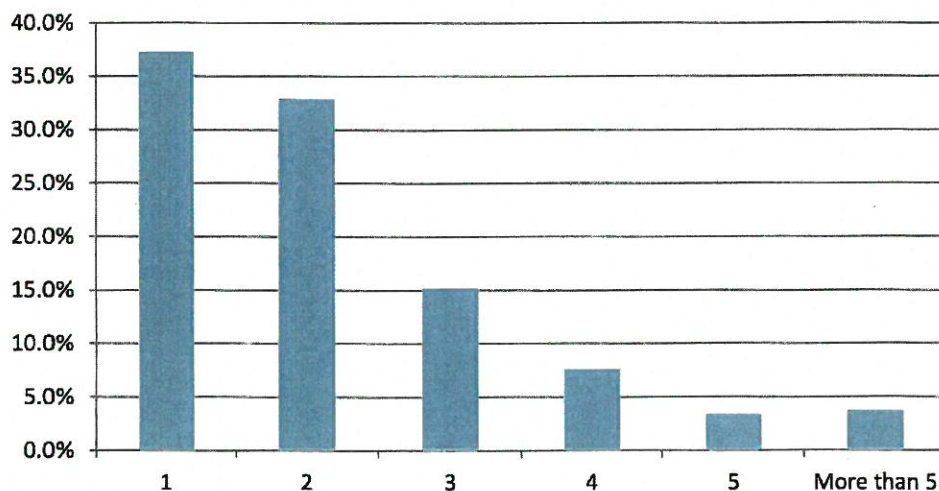
On average, how many patients are treated daily at your facility?



How many linear accelerators are used in your facility?

	N	Valid Percent	Cumulative Percent
1	221	37.3%	37.3%
2	195	32.9%	70.2%
3	90	15.2%	85.3%
4	45	7.6%	92.9%
5	20	3.4%	96.3%
More than 5	22	3.7%	100.0%
Total	593	100.0%	
Mean	2.2 (SD=1.38)		
Percentiles	5th=1.0, 25th=1.0, 50th=2.0 75th=3.0, 95th=5.0		

How many linear accelerators are used in your facility?

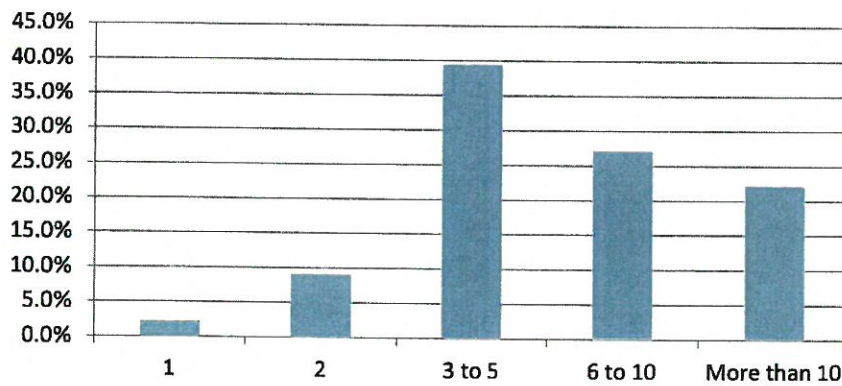


Personnel Demographics

How many full-time equivalent radiation therapists are budgeted in your department?

	N	Valid Percent	Cumulative Percent
1	13	2.3%	2.2%
2	52	9.1%	11.3%
3 to 5	226	39.4%	50.8%
6 to 10	155	27.1%	77.8%
More than 10	127	22.2%	100.0%
Total	573	100.0%	
Mean	7.3 (SD=5.39)		
Percentiles	5th=2.0, 25th=3.5, 50th=5.0 75th=10.0, 95th=20.0		

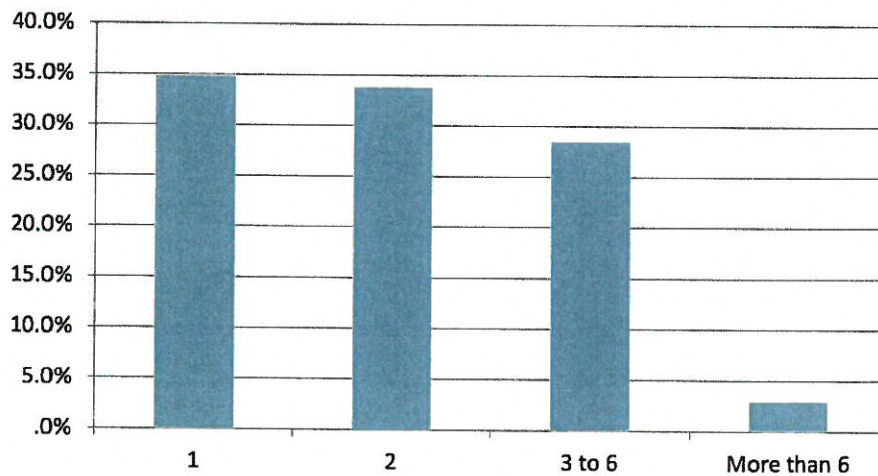
How many full-time equivalent radiation therapists are budgeted in your department?



How many full-time equivalent medical dosimetrists are budgeted in your department?

	N	Valid Percent	Cumulative Percent
1	177	34.8%	34.8%
2	172	33.8%	68.6%
3 to 6	145	28.5%	97.1%
More than 6	15	2.9%	100.0%
Total	509	100.0%	
Mean	2.4 (SD=1.62)		
Percentiles	5th=1.0, 25th=1.0, 50th=2.0 75th=3.0, 95th=6.0		

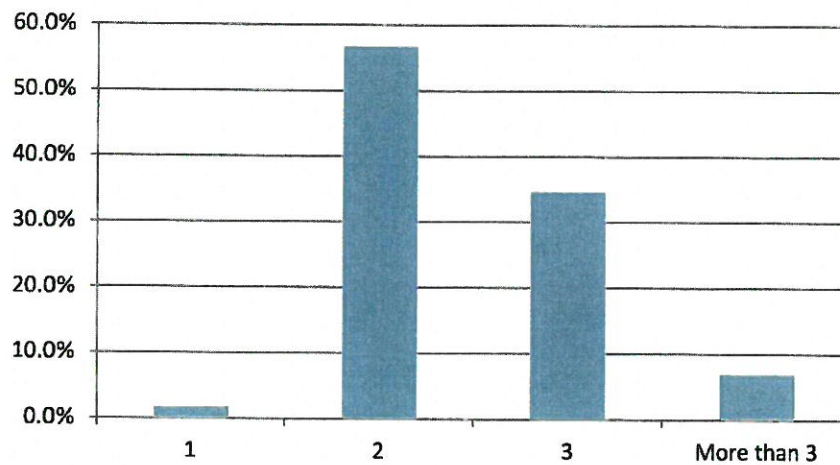
How many full-time equivalent medical dosimetrists are budgeted in your department?



On average, how many therapists per linear accelerator are routinely scheduled at your facility?

	N	Valid Percent	Cumulative Percent
1	10	1.7%	1.7%
2	343	56.7%	58.4%
3	210	34.7%	93.1%
More than 3	42	6.9%	100.0%
Total	605	100.0%	
Mean	2.4 (SD=0.654)		
Percentiles	5th=2.0, 25th=2.0, 50th=2.0 75th=3.0, 95th=4.0		

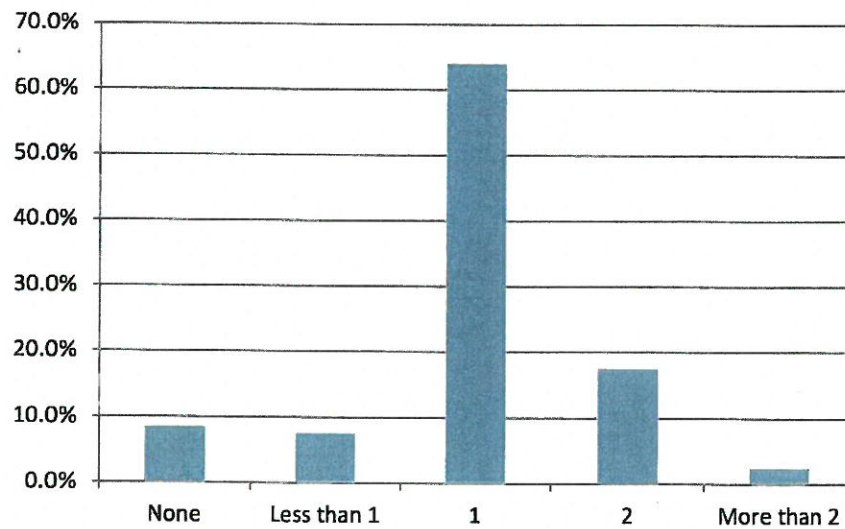
On average, how many therapists per linear accelerator are routinely scheduled at your facility?



On average, how many dosimetrists per linear accelerator are routinely scheduled at your facility?

	N	Valid Percent	Cumulative Percent
None	47	8.5%	8.5%
Less than 1	42	7.6%	16.2%
1	352	64.0%	80.2%
2	96	17.5%	97.6%
More than 2	13	2.4%	100.0%
Total	552	100.0%	
Mean	1.1 (SD=0.708)		
Percentiles	5th=0.0, 25th=1.0, 50th=1.0 75th=1.0, 95th=2.0		

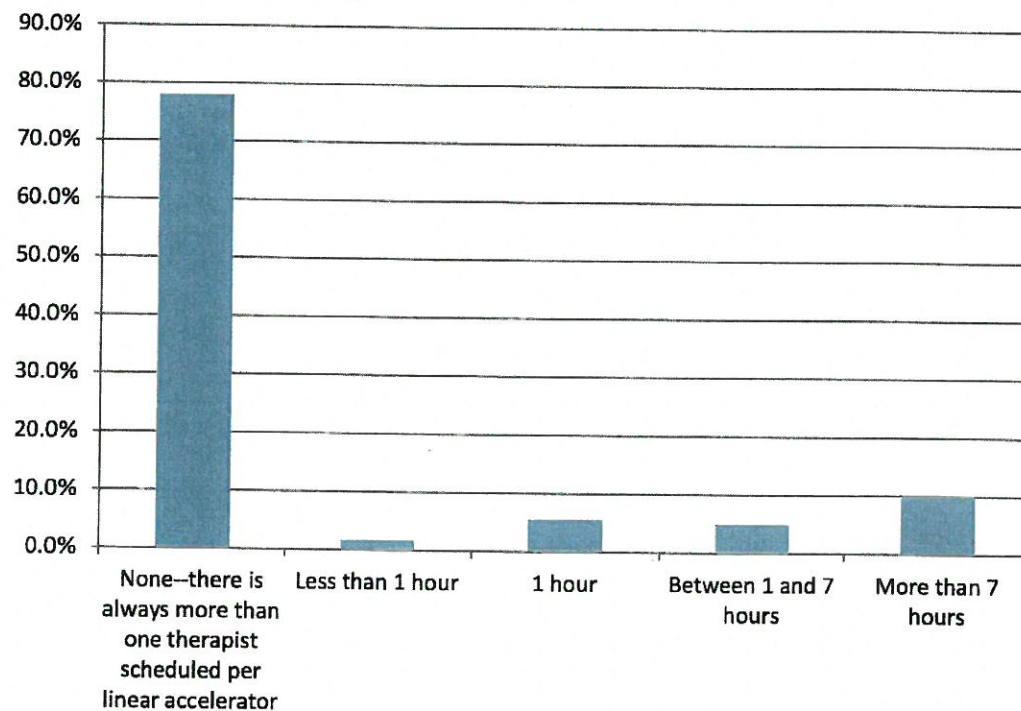
On average, how many dosimetrists per linear accelerator are routinely scheduled at your facility?



How many, if any, hours per day does your facility routinely schedule only one therapist per linear accelerator?

	N	Valid Percent	Cumulative Percent
None--there is always more than one therapist scheduled per linear accelerator	461	77.9%	77.9%
Less than 1 hour	10	1.7%	79.6%
1 hour	33	5.6%	85.1%
Between 1 and 7 hours	29	4.9%	90.0%
More than 7 hours	59	10.0%	100.0%
Total	592	100.0%	
Mean	1.2 (SD=3.41)		
Percentiles	5th=0.0, 25th=0.0, 50th=0.0 75th=0.0, 95th=8.0		

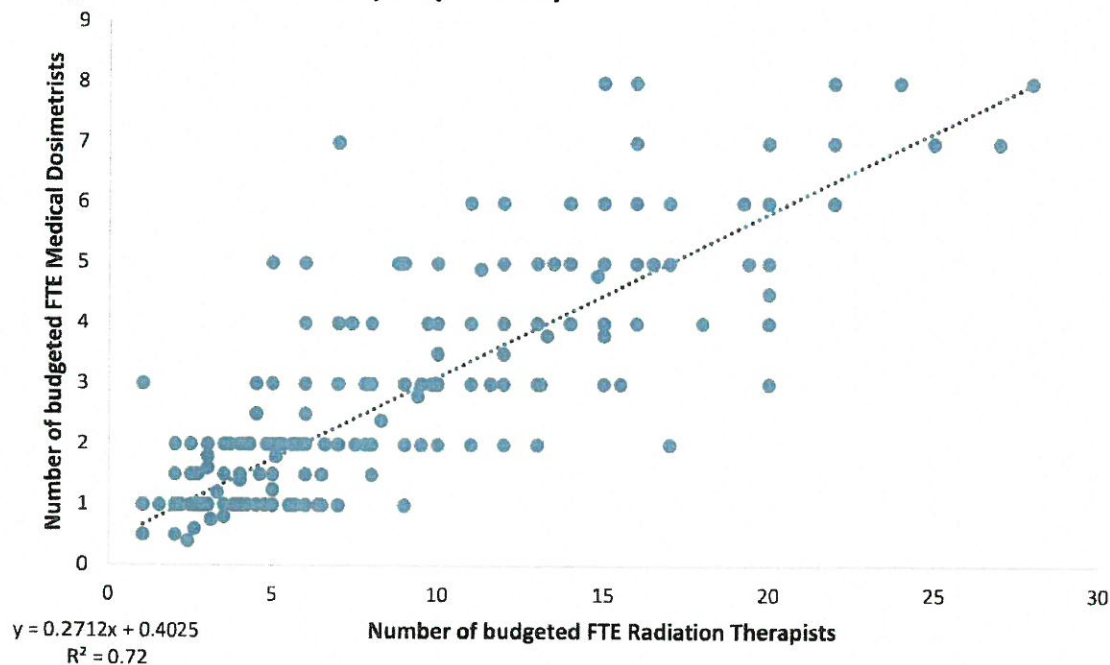
How many, if any, hours per day does your facility routinely schedule only one therapist per linear accelerator?

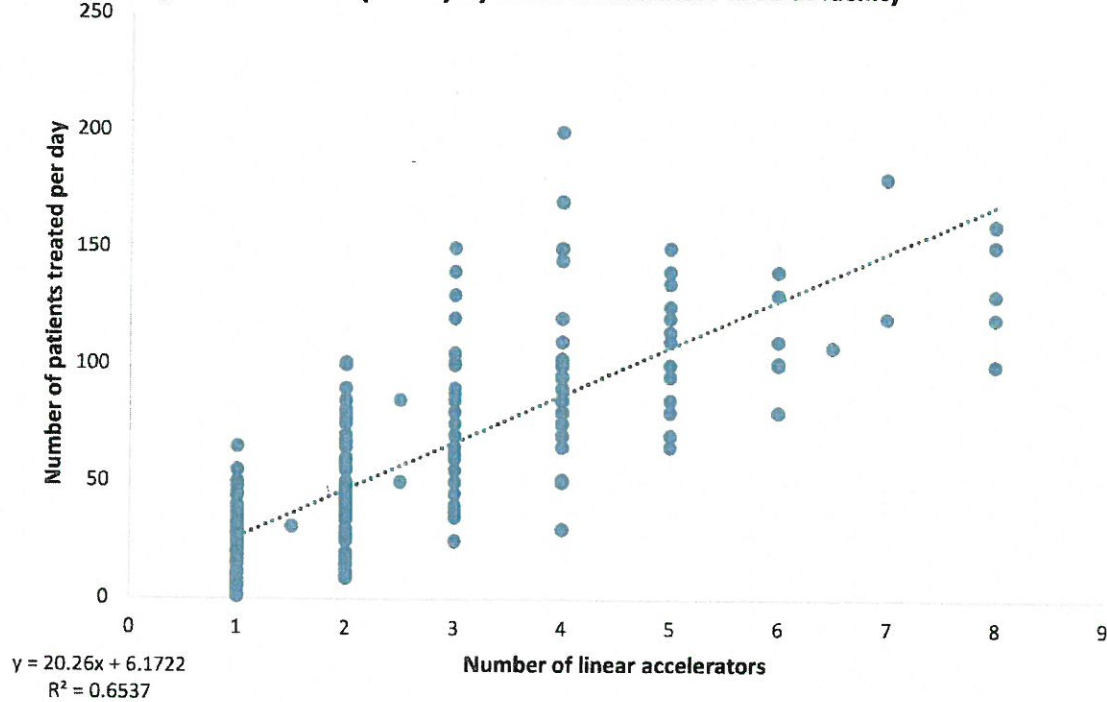
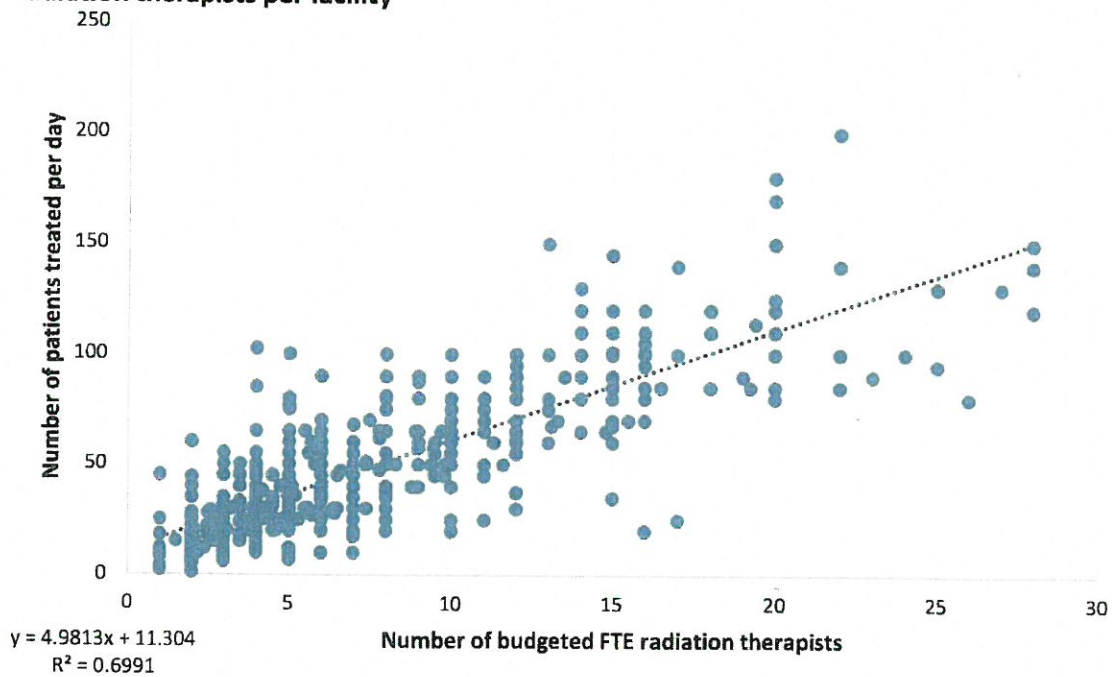


Appendix A. Scatterplots

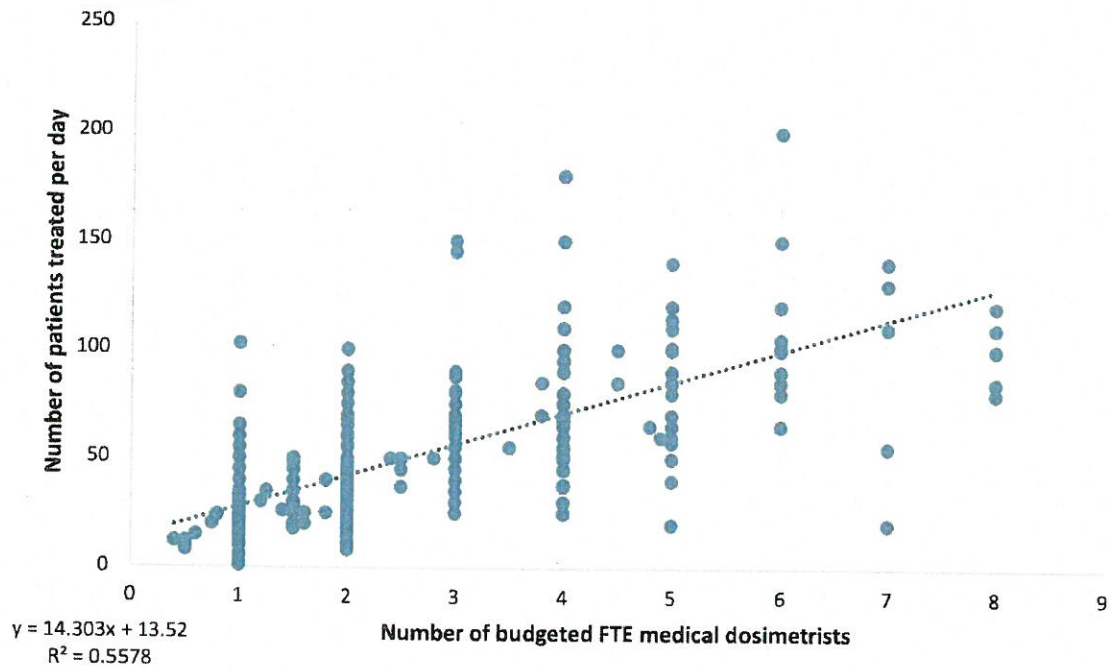
Below are scatterplots that demonstrate the observed relationship between selected variables from the survey. Please note that these scatterplots do not necessarily demonstrate any causal relation. They merely show how the given factors measured in the survey vary from each other. In each instance below, one variable is treated as independent (charted on the x-axis) and another is treated as dependent (charted on the y-axis). The points on the chart represent each of the observed data points from the survey. The diagonal line running across the chart represents the best-fit straight line through the observed data points. This is derived from the regression equation in the lower left-hand corner of the chart. The r^2 measures the proportion of variance among the data points accounted for by the regression equation. The closer the r^2 is to 1, the better the line fits the data; the closer the r^2 is to 0, the more poorly the line fits the data. Also listed is the ratio of the variable on the x-axis to the variable on the y-axis.

Number of budgeted FTE medical dosimetrists per facility by number of budgeted FTE radiation therapists per facility



Number of patients treated per day by linear accelerators used at facility**Number of patients treated per day by number of budgeted FTE radiation therapists per facility**

Number of patients treated per day by number of budgeted FTE medical dosimetrists





SERO

Care in action.

July 18, 2025

NC Division of Health Service Regulation
State Health Coordinating Council
Healthcare Planning Section
2704 Mail Service Center
Raleigh, NC 27699-2704

Dear Council Members:

I am writing to provide our group's full support of CaroMont Health's petition to place a linear accelerator in the 2026 State Medical Facilities Plan for Area 6. Our support is based on the following unique characteristics of our local situation:

- The two linear accelerators currently located in Gaston County at CaroMont Regional Medical Center are the busiest units among the state's top 15 cancer centers.
- Area 6 contains the following counties: Cleveland, Gaston, Lincoln and Rutherford. Based on available patient origin data and as explained in the petition, Lincoln and Rutherford counties should be aligned to other planning areas. The low utilization of the units in these two counties is suppressing the need for an additional unit in Gaston County.
- Since 2019, Gaston County's cancer incidence rate is higher than the rate of cancer seen across the other Area 6 counties.
- An additional linear accelerator in Gaston County will enhance local access to care and improve the quality of care provided to the community.

Thanks for your consideration of this critical petition. If I can be of assistance in any way, please do not hesitate to contact me.

Best regards,

Jerome Butler, MD
Radiation Oncologist

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