Introduction

With increasing medical costs and concerns about COVID-19 exposure, reducing financial and time burdens of cancer treatment is critical.1 In radiation oncology, use of hypofractionated short-course radiotherapy (SC-RT) can decrease burden on patients and the health care system.2,3 For indolent lymphomas, existing guidelines recommend 24 Gy in 12 treatments; however, recent experience has shown shorter regimens (ie, 4 Gy in 1-2 treatments) are effective for palliation and possibly cure.4,5 Short-course RT is associated with equivalent overall survival and offers logistical and toxicity benefits with modestly inferior local control.4 Emergency radiotherapy guidelines advocated SC-RT to reduce COVID-19 exposure.1 Extent of adoption and financial implications of SC-RT before COVID-19 remain unclear. We evaluated SC-RT use with US episode-based payment data from the Centers for Medicare & Medicaid Services.6

Methods

This cross-sectional study was approved by Memorial Sloan Kettering Cancer Center’s institutional review board; informed consent was waived because data were publicly available. The study followed the STROBE reporting guideline. Radiotherapy episodes from 2015 to 2019 were analyzed for Medicare beneficiaries 65 years or older who did not receive systemic therapy and lived more than 90 days after RT for lymphoma (eMethods in the Supplement). Delivery technique (conventional vs intensity-modulated RT [IMRT]), treatment year (2015-2019), age (65-74, 75-84, or ≥85 years), and site of care (freestanding vs hospital affiliated) were covariables. Use of SC-RT (1-10 treatments) vs long-course RT (LC-RT; 11-20 treatments) was evaluated by multivariable logistic regression, with the interaction between site of care and year investigating longitudinal patterns. Medicare spending was evaluated with multivariable linear regression. Data were analyzed using SAS Enterprise Guide, version 7.1. Two-sided \( P = .05 \) was significant.

Results

Of 10,447 radiation episodes, 50% were among women and 81% were among patients younger than 85 years. Most (78%) used conventional RT; however, IMRT use increased from 17% in 2015 to 25% in 2019 (\( P < .001 \)). Most patients (71%) received LC-RT. Receipt of SC-RT was associated with older age (≥85 vs 65-74 years: odds ratio [OR], 2.18; 95% CI, 1.94-2.45), hospital-affiliated vs free-standing site of care (OR, 1.74; 95% CI, 1.57-1.93), and conventional RT vs IMRT (OR, 5.18; 95% CI, 4.45-6.02) (Table). Increased SC-RT use was unique to hospital-affiliated sites (Figure).

Median total spending for SC-RT was $4278 (IQR, $2962-$5569) vs $8484 (IQR, $6919-$11 330) for LC-RT. For SC-RT, median total spending was $8048 (IQR, $5404-$9403) with IMRT vs $4121 (IQR, $2876-$5310) with conventional RT. Median total LC-RT spending was $13 085 (IQR, $11 445-$14 842) with IMRT vs $7657 (IQR, $6422-$8992) with conventional RT. Professional services–related spending was reduced with SC-RT (adjusted \( \beta \), $572; 95% CI, $550-$594; \( P < .001 \)), conventional RT, younger patients, and hospital-affiliated sites (Table). Technical services–related

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spending was reduced with SC-RT (adjusted β, $3168; 95% CI, $3096-$3241; \( P < .001 \)), younger patients, conventional RT, and freestanding sites (Table). In linear regression, delivery technique was associated with the largest contribution to total spending, followed by course length.

**Discussion**

Most Medicare beneficiaries treated with radiation monotherapy for lymphoma between 2015 and 2019 received LC-RT. Use of LC-RT has important financial implications given higher total spending. Despite lower health care spending and reduced time, travel, and costs for patients, SC-RT was used in only 29% of patients by 2019. Whereas practice patterns may reflect site-specific case mixes, ensuring differences do not reflect competing financial incentives owing to reimbursement structures or opinions on evidence-based practice is important. Increases in spending were greatest for IMRT; therefore, regimen and technique should be considered for cost savings. Financial alignment with value-based practice irrespective of site of care is critical; future studies may help

### Table. Results From Multivariable Logistic Regression Assessing Use of SC-RT and From Multivariable Linear Regression Modeling of Medicare Spending

<table>
<thead>
<tr>
<th>Variable</th>
<th>Use of SC-RT Adjusted OR (95% CI)*</th>
<th>P value</th>
<th>Total spending ( \beta ) (95% CI), $</th>
<th>( P ) value</th>
<th>Professional spending ( \beta ) (95% CI), $</th>
<th>( P ) value</th>
<th>Technical spending ( \beta ) (95% CI), $</th>
<th>( P ) value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td></td>
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<tr>
<td>75-84</td>
<td>1.27 (1.15 to 1.40)</td>
<td>&lt;.001</td>
<td>62 (-25 to 149)</td>
<td>.16</td>
<td>18 (-2 to 39)</td>
<td>.08</td>
<td>44 (-27 to 114)</td>
<td>.22</td>
</tr>
<tr>
<td>≥85</td>
<td>2.18 (1.94 to 2.45)</td>
<td>&lt;.001</td>
<td>212 (104 to 320)</td>
<td>&lt;.001</td>
<td>42 (16 to 68)</td>
<td>.001</td>
<td>169 (82 to 257)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Year</td>
<td>1.13 (1.10 to 1.17)</td>
<td>&lt;.001</td>
<td>-59 (-86 to -31)</td>
<td>&lt;.001</td>
<td>-20 (-27 to -13)</td>
<td>&lt;.001</td>
<td>-39 (-61 to -16)</td>
<td>&lt;.001</td>
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<tr>
<td>Technique</td>
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<tr>
<td>IMRT</td>
<td>1 [Reference]</td>
<td>NA</td>
<td>-5167 (-5264 to -5070)</td>
<td>&lt;.001</td>
<td>-719 (-743 to -696)</td>
<td>&lt;.001</td>
<td>-4448 (-4526 to -4369)</td>
<td>&lt;.001</td>
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<tr>
<td>Conventional RT</td>
<td>5.18 (4.45 to 6.02)</td>
<td>&lt;.001</td>
<td>1 [Reference]</td>
<td>NA</td>
<td>1 [Reference]</td>
<td>NA</td>
<td>1 [Reference]</td>
<td>NA</td>
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<tr>
<td>Site of care</td>
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<tr>
<td>Freestanding</td>
<td>1.74 (1.57 to 1.93)</td>
<td>&lt;.001</td>
<td>298 (213 to 383)</td>
<td>&lt;.001</td>
<td>-87 (-107 to -66)</td>
<td>&lt;.001</td>
<td>385 (316 to 454)</td>
<td>&lt;.001</td>
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<tr>
<td>Hospital affiliated</td>
<td>1.74 (1.57 to 1.93)</td>
<td>&lt;.001</td>
<td>298 (213 to 383)</td>
<td>&lt;.001</td>
<td>-87 (-107 to -66)</td>
<td>&lt;.001</td>
<td>385 (316 to 454)</td>
<td>&lt;.001</td>
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<td>Regimen</td>
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<tr>
<td>LC-RT</td>
<td>1.74 (1.57 to 1.93)</td>
<td>&lt;.001</td>
<td>3740 (3650 to 3830)</td>
<td>&lt;.001</td>
<td>572 (550 to 594)</td>
<td>&lt;.001</td>
<td>3168 (3096 to 3241)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

* Abbreviations: IMRT, intensity-modulated radiotherapy; LC-RT, long-course radiotherapy; NA, not applicable; OR, odds ratio; SC-RT, short-course radiotherapy.

* The ORs are from multivariable logistic regression including the covariables listed and the interaction between site of care and year. Use of SC-RT over time was significantly different between freestanding and hospital affiliated centers (Figure).

**Figure. Proportion of Lymphoma Radiation Episodes Delivered With Short-Course (SC) vs Long-Course (LC) Radiotherapy (RT) From 2015 to 2019, Stratified by Site of Care**

Short-course RT involves 1 to 10 treatments and LC-RT, 11 to 20 treatments. The interaction between site of care and year of treatment was significant (\( P = .01 \)) when controlling for patient age and RT technique (conventional RT vs intensity-modulated RT) on multivariable logistic regression.
refine the balance between local control, patient treatment-related burden, and health care spending. Wider adoption of SC-RT may help reduce systemwide costs and optimize personalized RT decision-making. Limitations include lack of available clinical variables; despite efforts to limit the analysis to indolent lymphomas for which SC-RT is considered, more aggressive subtypes may have been included.

ARTICLE INFORMATION

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Corresponding Author: Brandon S. Imber, MD, MA, Department of Radiation Oncology–David H. Koch Center for Cancer Care, Memorial Sloan Kettering Cancer Center, 530 E 74th St, New York, NY 10021 (imberb@mskcc.org).

Author Affiliations: Department of Radiation Oncology, Memorial Sloan Kettering Cancer Center, New York, New York.

Author Contributions: Drs Tringale and Imber had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Concept and design: Tringale, Hubbeling, Hajj, Yahalom, Imber.

Acquisition, analysis, or interpretation of data: Tringale, Chino, Imber.

Drafting of the manuscript: Tringale, Yahalom, Imber.

Critical revision of the manuscript for important intellectual content: Tringale, Hubbeling, Chino, Hajj, Imber.

Statistical analysis: Tringale.

Obtained funding: Yahalom, Imber.

Administrative, technical, or material support: Yahalom.

Supervision: Hajj, Yahalom, Imber.

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Additional Information: The data used in this study are publicly available at https://innovation.cms.gov/innovation-models/radiation-oncology-model.

REFERENCES


