

**Research Article**

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Cost of Care Related to Treatment of Bone Metastases: Real World Data from a National Health Insurance Provider

Parisa Shamesfandabadi^{1*}, Oralia G Dominic², Matthew Fickie², Jonathan Jablow², Zachary D Horne¹, Paul B Renz¹, Sushil Beriwal¹, Rodney E Wegner¹

¹Allegheny Health Network Cancer Institute, Department of Radiation Oncology, Pittsburgh PA, USA

²Highmark Inc., Pittsburgh PA, USA

***Corresponding author:** Parisa Shamesfandabadi, M.D, Allegheny Health Network, Department of Radiation Oncology, 320 E North Ave, Pittsburgh, PA 15215, USA

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Abstract

Purpose/Objectives: The study aims to investigate the economic implications of treating bone metastases, a frequent occurrence in advanced malignancies, through radiation therapy. Despite its efficacy in symptom alleviation, the associated costs with diverse radiation techniques and fractionation schemes remain poorly understood.

Methods: This study was a secondary data analysis of medical claims data using a retrospective design among insured members in Pennsylvania, Delaware, and West Virginia with an ICD-10 code of C79.51 from 1/1/2016 to 9/30/2021. We looked at which radiation technique was used (intensity modulated radiation therapy (IMRT) vs. 3D conformal radiotherapy (3D CRT) vs. complex isodose plan) also the use of image guided radiation therapy (IGRT).

Results: For 29,201 patients, a median of 4,866 claims per year was observed (2,744-6,000). The median total cost of care was \$181,918,217 (\$163,672,315-\$183,565,407). Most patients were treated using isodose complex technique or 3D CRT (combined 80-90%) with a relatively even split. The use of IMRT remained relatively stable over the timeframe (5-15%). The use of IGRT increased over time, with highest number of claims for IGRT being 2020 (458 claims) (median 266, range: 183-458). The median cost per year for all care related to ICD10 C79.51 was \$10,887,581, \$7,274,264, and \$1,902,141 for patients treated with 3D CRT, IMRT, and isodose complex, respectively.

Conclusions: Radiation remains a widely used technique for the palliation of bone metastases. The cost of care related to its use are significant. The use of IGRT increased over time, with no obvious impact on overall cost of care. The use of IMRT remained low for bone metastases, with an associated increase in cost of care. The overall cost of care remained lowest for those patients treated with isodose complex treatment.

Keywords: Cost of care, Real world data, Bone metastases, Radiation

Introduction

Bone metastases, also known as skeletal metastases, are a common complication and occur in up to 80% patients with advanced stage malignancy such as breast, prostate, lung and thyroid cancer [1,2]. These metastases can cause significant

morbidity and impact the quality of life of patients, including pain, pathological fractures and spinal cord compression [3,4]. Radiation therapy is a highly effective modality for the treatment of symptomatic bone metastases [5-7] for relieving pain and improving the quality of life [8]. Radiation therapy improves the detrimental effects of bone metastases by producing ossification, and hence diminishing osteoclast activation and killing tumor cells [7]. While radiation therapy is proven to be effective; the cost of care can vary significantly depending on the specific technique and number of fractions used [9]. Several different techniques of radiation therapy are used to treat bone metastases, including intensity modulated radiation therapy (IMRT), 3D conformal radiotherapy (3DCRT), and complex isodose plan [10-12]. The choice of technique can depend on various factors such as the location and number of metastases, patient's overall health and comorbidities and availability of equipment. Each technique has its own advantages and disadvantages, and it is important to consider both clinical outcomes and cost-effectiveness when choosing the appropriate technique [12,13]. In this study, we will access payer claims data from a health insurance provider in Pennsylvania (PA), Delaware (DE), and West Virginia (WV) to help determine

the actual cost of care for patients with bone metastases treated with radiation. By analyzing these data, we aim to provide a comprehensive understanding of the cost of care for patients with bone metastases treated with radiation therapy, and to help identify areas where cost savings can be achieved without compromising patient outcomes.

Methods

This study is a secondary data analysis of medical claims data using a retrospective design among insured members in PA, DE, and WV (Figure 1) with an ICD-10 code of C79.51 (secondary malignant neoplasm of bone) and history of radiation therapy billed under that code from 1/1/2016 to 9/30/2021. Patients were grouped by age, sex, and geographical region. Number of claims and total cost of care were tabulated by year. We also examined which radiation technique was used IMRT vs. 3D CRT vs. complex isodose plan based on CPT codes. Lastly, we looked at the use of image guided radiation therapy (IGRT) over that same time period, again using CPT codes. Data was obtained from electronic health records of the health insurance provider, and de-identified before analysis to ensure patient confidentiality. This was IRB approved as well.



Figure 1

Statistical analysis was performed using SPSS software (version 9.4). Descriptive statistics were used to summarize the demographic characteristics of the study population and the number of claims and total cost of care by year. The chi-square test was used to compare the use of different radiation techniques and IGRT between different subgroups. A p-value less than 0.05 was considered statistically significant. To ensure the quality of the data, the data was reviewed by a medical expert for accuracy and completeness. Additionally, sensitivity analysis was performed to evaluate the robustness of the results. This included the exclusion of patients with missing data and the inclusion of patients with multiple primary malignancies. To further explore the cost of care, we also conducted a cost-effectiveness analysis by comparing the cost of care for each technique and the number of fractions used. This was done by calculating the cost per fraction for each technique

and comparing the costs between different subgroups.

Results

In this study, we identified 29,201 patients treated with radiation for diagnosis code C79.51 between 2016 and 2021. The median number of claims per year was 4,866 (2,744-6,000). Fifty-one percent of patients were male (13,676). The majority of patients (79%) resided in PA. The median total cost of care related to ICD-10 C79.51 was \$181,918,217 (\$163,672,315-\$183,565,407). The median number of claims for those years was 95,024 (89,870-101,449). The number of claims per patient varied from 2.3-5.0 and 3.5-10.2 for isodose complex treatment and IMRT, respectively. Most patients were treated using the isodose complex technique or 3D CRT (combined 80-90%) with a relatively even split. The use of IMRT remained relatively stable over the same timeframe (5-15%).

The use of IGRT increased over time, with the highest number of claims for IGRT being 2020 (458 claims) (median 266, range: 183-458). The median cost per year for all care related to ICD10 C79.51 was \$10,887,581, \$7,274,264, and \$1,902,141 for patients treated with 3D CRT, IMRT, and isodose complex, respectively (Table 1).

In the sensitivity analysis, the exclusion of patients with missing data did not significantly impact the overall results. However, the inclusion of patients with multiple primary malignancies resulted in a slightly higher median cost of care.

Table 1

Table 1.	
Variable	Count (Volume)
Total patients with bone Metastases (C79.51)	29, 201
Number of claims per year	Median 4,866 (2,744 - 6,000)
Sex	Male 51% (13,676) Female 49% (15,525)
Geography -State with highest member volume	Pennsylvania (79%)
Total cost of care	Median \$181,918,217 (\$163,672,315-\$183,565,407)
Number of claims for those years	Median 95,024 (89,870-101,449).
Number of claims per patient by radiation type	Isodose CT from 2.3-5.0 IMRT from 3.5-10.2
Use of IMRT trend	Remained relatively stable over the timeframe (5-15%).
Use of IGRT trend	Increased over time,(median 266, range: 183-458).
Cost per year	3D CRT median \$10,887,581 IMRT median \$7,274,264 Isodose median CT \$1,902,141
* Data source: medical claims data by geography (PA, DE, and WV), ICD-10 code (C79.51), history of radiation therapy billed under that code from 1/1/2016 to 9/30/2021.	

Discussion

The present study aimed to determine the actual cost of care for patients with bone metastases treated with radiation using real-world data from a national health insurance provider. The results of this study indicate that radiation therapy is a widely used technique for the palliation of bone metastases, and the cost of care related to its use is significant. Cost of care of a radiation therapy is dependent on both the type of technique and number of fractions used [18]. It is crucial to focus on cost-effectiveness for potential changes in standard of care as a study by Gillespie et al. found that radiation delivered prophylactically to asymptomatic, high-risk bone metastases reduced skeletal-related events and hospitalizations [23]. By being mindful of cost, we can ensure that effective and efficient treatments are accessible and affordable for all patients. IGRT is a technique that uses imaging during the radiation treatment to ensure accurate and reproducible patient positioning [20]. Despite the availability of IGRT techniques, their use may vary depending on factors such as individual practitioner preferences, institutional practices, and insurance authorization. For example, a study by Tunceroglu et al. found that IGRT may offer greater pain

control through improved patient setup [14]. Our study showed the use of IGRT increased over time but did not have an obvious impact on the overall cost of care. The use of IMRT remained low for bone metastases but was not surprisingly associated with an increase in the cost of care. IMRT uses delivery methods that modulate the fluence distribution perpendicular to the direction of the incident beam and hence allows for manipulation of radiation beams to follow the shape of a tumor. This allows the therapy to release lower levels of dose into the interior of a higher dose volume, which provides this form of radiotherapy with an advantage over 3D CRT in terms of avoiding damage to nearby normal tissue [15]. Typically, IMRT is used for bone metastases in the reirradiation setting [24]. The overall cost of care remained lowest for those patients treated with isodose complex treatment, which can be an indication that it is favorable in terms of cost-effectiveness for patients and healthcare allocation. These findings are consistent with previous studies that have shown that IMRT is more expensive than other radiation techniques such as 3D-CRT and complex isodose plan [16]. A study by Nguyen et al. found that IMRT was associated with a significantly higher cost than 3D-CRT for the treatment of prostate cancer [19]. Similarly, a study by Kale et al. and Yong et al. found the same result

for treatment of lung cancer and oropharyngeal cancer, respectively [21,22]. The increase in the use of IMRT [25] over time may be due to the growing availability and accessibility of this technology. However, it is important to note that this study did not evaluate the clinical outcomes or effectiveness of the different radiation techniques, and it is possible that IMRT may be more effective in some cases and justify the added cost. Therefore, it is important to conduct a cost-effectiveness analysis to evaluate the trade-off between the cost and clinical outcomes of different radiation techniques in bone metastases. It is also worth noting that this study was conducted in a specific geographic region and used data from a single insurance provider. Further research examining cost-effectiveness of radiation techniques in other regions and through other providers would be necessary to generalize the results to a greater population. Additionally, this study was based on claims data, which may have limitations such as missing or inaccurate data. Claims data is dependent on accurate coding and billing practices and may not fully capture all relevant information.

It is important to note that the cost of care for bone metastases not only includes the cost of radiation therapy, but also the cost of other treatments such as surgery, chemotherapy, and pain management. Therefore, a comprehensive evaluation of the overall cost of care for bone metastases is necessary for future research and needs to be inclusive of the cost of all treatments used by the patient. Lastly, the study only covered a short period from 2016-2021, it would be useful to see the cost of care over a longer period of time for more accurate results. In conclusion, this study provides valuable information on the cost of care related to the treatment of bone metastases using radiation therapy in a specific geographic region. However, further research is needed to evaluate the cost-effectiveness of different radiation techniques in different regions and through other insurance providers. Additionally, future studies should also consider the clinical outcomes and overall cost of care including other treatments such as surgery, chemotherapy, and pain management. The results of this study can assist healthcare providers, payers, and policy makers in making informed decisions on the use of radiation therapy for the treatment of bone metastases and allocating resources effectively.

Conflicts of Interest

None.

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None List of where the study has been presented in: Poster presentation at ASTRO 2022.

Author contributions

PS, OGD, MF, JJ, ZDH, PBR, SB, REW: Design, manuscript drafting, revision. PS, OGD, MF, JJ, REW: Data analysis, manuscript drafting, revision, and final approval.

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