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Economic Evaluation of Treating Skeletal-Related Events among Prostate Cancer Patients

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ABSTRACT

Objectives: To evaluate the economic burden of treating skeletal-related events (SREs) in prostate cancer (PC) patients with bone metastasis from an insurer perspective. **Methods:** We conducted a retrospective cohort analysis using claims data. PC patients with bone metastasis were identified in the MarketScan Databases between January 1, 2004, and March 1, 2014. The propensity score matching approach was used to match patients with SREs to those without SREs. A pseudo-SRE date was assigned to the control group. We compared 6-month and 12-month total costs of patients between two groups after the SRE or pseudo-SRE date. All costs were adjusted to 2014 US$. **Results:** We identified 4083 PC men with bone metastasis, from which 787 patients with SREs were matched (1:1) to those without SREs. On average, the total 6-month cost of treating patients with SREs was $43,746 compared with $25,956 in the matched control cohort ($P < 0.05$). The largest proportion of differences in costs between the two groups was incurred in the first month after the SRE index date or the pseudo-SRE date ($14,979 vs. $4,849; $P < 0.05$) and was mostly attributable to outpatient visits (43.4%; $P < 0.05$) and inpatient hospitalization (33.1%; $P < 0.05$). The total cost per patient over the 12-month period was $22,171 higher among patients with SREs than among patients without SREs ($P < 0.05$). **Conclusions:** Our findings suggest that SREs impose considerable burden on health resource utilization for payers. Costs attributable to SREs were substantial. Most costs were incurred in the first month after the occurrence of SREs. Although costs decreased thereafter, they remained significantly higher for patients with SREs in subsequent months compared with patients without SREs.

Keywords: burden of illness, claims data, health care costs, prostate cancer.

Introduction

In the United States, approximately 2.8 million men are living with prostate cancer (PC) [1]. It is one of the top five leading causes of cancer deaths in both males and the general population. The lifetime risk of developing PC in men is about 15% and it increases with age, especially among those aged 65 years or older [1,2]. More than 90% of PC patients are diagnosed at the local and regional stage, and 4% have distant metastasis at the time of diagnosis [2].

Bone is one of the most common sites of distant metastasis in PC patients. It has been reported that up to 90% of men with advanced PC will eventually develop bone metastasis [3]. Bone metastasis can result in bone pain and other types of skeletal-related events (SREs), including pathologic fracture, radiation to bone, spinal cord compression, and bone surgery [4,5]. The exact incidence of SREs in PC patients with bone metastasis is still unknown in the United States. Two studies using retrospective claims data found that more than half of the men experienced at least one SRE within 1.5 years after their bone metastasis diagnosis [5,6]. A population-based study conducted in Denmark found that the 1-year cumulative incidence of SREs among PC patients with bone metastasis is 46% [7]. Results also showed that the 1-year survival rate was about 40% and the 5-year survival rate was less than 1% in those with both bone metastasis and SREs.

Three studies have estimated the health care costs of treating metastatic PC patients with SREs among commercially insured population in the United States using descriptive statistics. A study based on 342 PC patients found that the average annual cost after the diagnosis of an SRE was about $12,500 (2006 US$), ranging from $8,484 to $26,384 depending on the number of SREs that patients had experienced [5]. Barlev et al. [8] reported costs of inpatient treatment for each admission associated with different types of SREs. Among them, the cost of inpatient services treating spinal cord compression ($59,788, 2009 US$) was the highest, followed by pathologic fracture ($22,390, 2009 US$) and surgery to the bone ($42,094, 2009 US$). Hagiwara et al. [6] measured costs of an SRE episode and found that the mean cost per episode was $20,984 (2010 US$) [6]. Using the 2000 to 2007 linked Surveillance,

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Epidemiology and End Results-Medicare data set, a recent study by Jayasekera et al. [4] applied a pre-post design and propensity score matching techniques to compare costs between PC patients with SREs and those without SREs. The study reported that the 12-month cost per patient older than 65 years with SREs was about $30,000 (2009 US$) higher than that for patients without SREs.

In the present study, the main objective was to estimate health care costs associated with SRE and non-SRE health states among PC patients with bone metastasis on a commercially insured population. Previous studies using commercially insured patients did not include any control groups, nor did they include costs paid by Medicare among those patients who were also eligible for Medicare. On the basis of data from commercially insured patients and Medicare-eligible retirees with employer-sponsored Medicare supplemental plans, the study aimed to quantify the excess costs associated with having SREs by examining all-cause costs between two comparable groups of metastatic PC patients with or without SREs.

Methods

Data Sources

This study was a retrospective quasi-experimental analysis of the Truven Health MarketScan Commercial Database and the Medicare Supplemental Database from January 1, 2004, to March 1, 2014, which contain individual-level health claims information for inpatient, outpatient, and outpatient prescription drug services of approximately 90 million employees and their dependents. The Medicare database contains medical information of individuals with Medicare supplement insurance paid by employers. Both the Medicare-paid amounts and the employer-paid supplemental insurance amounts are included in this database. Patients are covered under various fee-for-service and capitated health plans, including exclusive provider organizations, preferred provider organizations, point-of-service plans, indemnity plans, and health maintenance organizations. The MarketScan Research Databases are de-identified and compliant with the Health Insurance Portability and Accountability Act of 1996, and so the study was exempt from a review by an institutional review board.

Sample Selection

Eligible patients had confirmed primary diagnoses of both PC and bone metastasis. Specifically, men older than 18 years with at least one inpatient diagnosis or two outpatient diagnosis codes for bone metastasis (*International Classification of Diseases, Ninth Revision, Clinical Modification* [*ICD-9-CM*] diagnosis code 198.5) between 2005 and 2013 were initially identified. The first diagnosis date of bone metastasis was defined as the index date. We then selected patients who had at least 12 months of continuous coverage with at least one inpatient or two outpatient PC diagnoses (*ICD-9-CM* code 185) before the index date (baseline).

We identified patients with evidence of SREs occurring after bone metastasis diagnosis using both diagnosis and procedure codes. An SRE was defined as the presence of any of the following events: bone surgery, pathological bone fracture, radiation therapy, and spinal cord compression. The selection of diagnosis and procedure codes was based on published algorithms and expert opinion provided by oncologists [4].

Patients were excluded if they had evidence of any additional primary cancer diagnosis during the 12-month baseline period. We also excluded patients with evidence of nonpathologic fractures (*ICD-9-CM* code 800-829) and bone surgery episodes with previous nonroutine or accident falls (*ICD-9-CM* code E880-E888). We focused only on patients with incident bone metastasis and SREs. Therefore, we also excluded patients who had diagnoses of bone metastasis and SREs during the 12-month washout period.

Patient Characteristics

We examined the baseline demographic and clinical characteristics for patients with and without SREs, measured as of the patients' index dates. Demographic characteristics included patient age, geographic region, health plan type, data type, and total health care costs during the baseline period (12 months before the first bone metastasis diagnosis). Clinical characteristics included patient Charlson comorbidity index (CCI) score, year of the first bone metastasis diagnosis, length of follow-up from the index date to the last date of continuous enrollment, and presence of comorbid conditions such as osteoarthritis, osteoporosis, and rheumatoid arthritis.

Propensity Score Matching

We used propensity score matching to ensure that metastatic PC patients with SREs were comparable on all baseline covariates with those without SREs. A logistic regression model was used to calculate the propensity scores for all patients, representing the probability of a patient with certain demographic and clinical characteristics being present with an SRE. Then, patients with SREs and those without SREs were matched at a minimum of 1:1 using the greedy-matching algorithm [9]. All the aforementioned patient demographic and clinical characteristics were included for propensity score matching (see Table 1).

For patients without SREs, we assigned a pseudo-SRE date that was parallel to the SRE index date of the SRE cohort after propensity score matching, which allowed a match on time from bone metastasis to the time interval over which costs were estimated, controlling for impact of time on disease progression. We examined the similarity of matched SRE and non-SRE subjects by comparing the means of continuous covariates and the distribution of categorical covariates between two cohorts. Chi-square tests and *t* statistics were used to determine statistical significance. Results were considered as marginally significant if the P value was between 0.05 and 0.1.

Health Care Expenditures

After propensity score matching, we selected those patients with at least 6 months of continuous enrollment after the SRE or pseudo-SRE date. We reported total costs paid by both private insurers and Medicare (represented as coordination of benefits amount), which were categorized by sources of care, including inpatient service, prescriptions, emergency room, outpatient hospital, office, and other types of visits (e.g., urgent care visits). We also characterized changes in health care costs by measuring monthly costs before and after the SRE diagnosis. Finally, we computed costs of patients with different types and number of SREs.

For the base-case analysis, we measured and compared 6-month all-cause costs (plan paid amount) between matched SRE and non-SRE subjects. We conducted sensitivity analysis by selecting a longer time horizon (12 months) to measure the average annual cost related to SREs. We standardized all costs by converting them to 2014 US$.

Results

We identified 4083 PC patients with bone metastasis meeting the inclusion and exclusion criteria (Fig. 1). Among them, 47.3%