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Modeling Management Strategies for Clinical Stage I Seminoma: Direct and Indirect Costs for the First 5 Years

Khanh N. Pham, Richard B. Johnston, Claudio Jeldres, Craig R. Nichols and Christopher R. Porter*

From the Section of Urology and Renal Transplantation, Virginia Mason, Seattle, Washington

Abstract

Introduction: Clinical stage I seminoma can be managed with surveillance, chemotherapy or radiotherapy with similar survival rates. However, costs and side effects vary among these treatment modalities. We created a model to estimate the direct and indirect costs during the first 5 years of treatment for the 3 treatment strategies.

Methods: Markov model based analyses were conducted to compare the costs of the 3 management strategies during the first 5 years. In this model clinicians and patients were assumed to be 100% compliant with the 2012 NCCN Guidelines® for testicular cancer. Model parameters were collected from the Washington State CHARS (Comprehensive Hospital Abstract Reporting System), published literature and Medicare reimbursement amounts. A 5% annual health inflation rate was assumed.

Results: The model predicts an initial cost premium for carboplatin (1 cycle—$9,199.49; 2 cycles—$10,613.85) and radiotherapy ($9,532.80) compared with surveillance ($9,065.31). Radiotherapy (145.8 hours) and surveillance (123.0 hours) require more patient time than carboplatin (1 cycle—93.2 hours, 2 cycles—106.3 hours). When the direct and indirect costs are considered, the least expensive management strategy is surveillance.

Conclusions: Surveillance is the most cost-effective management strategy for clinical stage I seminoma during the first 5 years of treatment. Although not evaluated in this analysis, costs of late side effects associated with radiotherapy and chemotherapy should be considered. Due to potentially minimal late side effects and superior cost-effectiveness, surveillance represents a safe, cost-effective and time effective option for the management of stage I seminoma.

Key Words: seminoma, costs and cost analysis, watchful waiting, drug therapy, radiotherapy

Abbreviations and Acronyms

ART = assisted reproductive therapy

BEP = bleomycin, etoposide and cisplatin

CSS = cause specific survival

CT = computerized tomogram

IVF = in vitro fertilization

Testicular cancer is the most common solid organ tumor in young men 20 to 35 years old. The WHO predicted that nearly 4,000 new cases of stage I pure seminoma testicular cancer would be diagnosed in the United States in 2011. Fortunately, testicular cancer is one of the most curable malignancies, with only 370 testicular cancer specific deaths predicted for 2011 among the 8,000 patients with newly diagnosed testicular cancer, mostly from higher stage disease. The lifetime risk of testis cancer is 1 in 300 but there is only a 1 in 5,000 lifetime risk of death from testicular cancer.[1] The overall CSS for clinical stage I seminoma approaches 100% and the actuarial 5-year CSS is more than 99% regardless of treatment strategy.[2]

With these excellent and equivalent oncologic outcomes, decisions regarding testicular cancer treatment must focus on patient preference, quality of life and cost outcomes. The preservation of fertility and sexual function represent important quality of life parameters in these young men. Cost and treatment burden with respect to time are also important factors to consider.

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* Correspondence: Section of Urology and Renal Transplantation, Virginia Mason, 1100 Ninth Ave., C7-URO, Seattle, Washington 98101 (telephone: 206-223-6772; FAX: 206-223-7650; *e-mail address:* Christopher.Porter@vmmc.org).

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In general, studies regarding the cost of treatments have 2 main limitations. 1) If the study duration is too short, then long-term cost implications will be missed. However, results of long-term studies may be based on outdated treatments and, therefore, no longer apply to modern practice. 2) If a modeling strategy is applied using previously published data to predict rates and likely outcomes, the model is dependent on the type and accuracy of the available data. For stage I seminoma the long-term followup data for carboplatin are limited to less than 10 years. Radiation complication data are based on patients treated up to 20 years ago and, therefore, these results may differ for a patient treated today. In addition, surveillance schedules for imaging are rapidly and safely being downsized as outcomes of large experiences with surveillance using lesser schedules become available. To overcome these difficulties we developed a detailed mathematical decision analysis model comparing the projected management costs for stage I seminoma during the first 5 years of treatment.

Materials and Methods

A Markov model based mathematical decision analysis was performed to project management costs for the first 5 years of treatment for stage I seminoma. The model was built on a meta-analysis of the testicular cancer literature and published guidelines. The model attempts to incorporate the full range of clinical outcomes downstream from orchiectomy. We defined the 2 separate costs of 1) direct health care costs or treatment costs of clinical management following NCCN Guidelines, and 2) ancillary costs to the patients, or peri-treatment costs, including time off work to attend appointments, cost of sperm storage and ART costs.[3] Using the Markov model the treatment and peri-treatment costs of the first 5 years for the 3 treatment strategies were evaluated. For each strategy the simulation costs were all discounted at an annual rate of 5%. The cost model was programmed into TreeAge Pro Healthcare software (TreeAge Software Inc., Williamstown, Massachusetts).

We assumed that all patients were treated identically up to the point of deciding on surveillance, carboplatin (1 or 2 cycles) or radiation treatment and these upstream costs were not incorporated into the model. Downstream of the original treatment decision, the model incorporates potential clinical outcomes such as need for clinic appointments and pelvic and abdominal CTs. It also includes primary treatment failure, the need for 3 cycles of bleomycin, etoposide and cisplatin chemotherapy for all patients experiencing relapse after active surveillance, adjuvant radiation therapy and adjuvant carboplatin. We additionally assumed that BEP completed active therapy for patients with disease relapse consistent with reports that BEP is associated with long-term disease survival in virtually all patients with disease relapse on active surveillance, or after adjuvant radiation or carboplatin. Peri-treatment costs incurred included sperm storage, ART costs, and time off work to attend followup tests and appointments. We did not attempt to quantify the impact on quality of life and subsequent cost implications or complications from initial therapy, such as acute radiation or carboplatin toxicity.

Expected outcomes were derived from quoted values in the testicular cancer guidelines of the NCCN® and European Association of Urology as well as a MEDLINE® search of the testicular cancer literature, with randomized trials being favored. In some cases the information was not available in the literature and had to be estimated. This was particularly true with sperm storage rates and use rates for which no definitive figures could be extracted from the published literature. Failure following radiation or carboplatin was defined as disease recurrence requiring BEP. Surveillance failure was defined as disease recurrence requiring salvage BEP.

All followup was as described in the 2012 NCCN Practice Guidelines in Oncology for a duration of 5 years. Medicare reimbursement rates in Washington state in 2012 were used to derive costs for radiotherapy, chemotherapy, professional fees, and imaging and laboratory tests. Future health care inflation was estimated at 5% per year and all costs in the model were deflated back to 2012 values. All costs reported in this study have been scaled to 2012 values to prevent confusion and allow better comparison across the treatment options. Time for treatment was calculated from time billed information extracted from the Washington State CHARS, a statewide database maintained by the Washington State Department of Health. Costs for failures were determined by scaling costs based on the average time to failure in the literature. These include direct and indirect costs of salvaging cases initially managed with surveillance, radiotherapy and carboplatin (table 1).[4–12]

Results

Expected failure rates and average time to failure for surveillance, carboplatin and radiotherapy based on the available literature are shown in table 1. The number of recommended tests and clinic reviews based on the 2012 NCCN Guidelines for each strategy were also tabulated. During 5 years patients managed with surveillance will undergo 12 office visits with blood tests, 7 abdominal/pelvic CTs and 3 chest x-rays. Patients treated with carboplatin over 5 years will be followed with 11 office visits with blood tests, 3 abdominal/pelvic CTs and 3 chest x-rays. Patients undergoing radiotherapy will be monitored for 5 years with 9 office visits with blood tests, 3 abdominal/pelvic CTs and 3 chest x-rays. Washington State 2012 Medicare reimbursement amounts for facility and professional fees are listed in table 2. The calculated number of hours needed off work to attend treatment and followup appointments is shown in table 3. Although similar for all 3 groups, carboplatin and radiotherapy are front-end loaded, so the times required are presented, excluding radiotherapy and carboplatin.

The total average costs estimated to treat 1 patient with surveillance, 1 or 2 cycles of carboplatin, and radiotherapy for 5 years are shown in table 4. In patients initially managed with surveillance, these estimates include the cost for 12.9% of patients electing to receive radiotherapy or carboplatin, despite not experiencing recurrence, as well as the cost of salvage therapy for 4.7% of patients with 3 cycles of BEP. Additionally, for patients treated with carboplatin the estimates included