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Time-driven activity-based cost comparison of prostate cancer brachytherapy and intensity-modulated radiation therapy

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ABSTRACT

PURPOSE: To evaluate the delivery cost of frequently used radiotherapy options offered to patients with intermediate- to high-risk prostate cancer using time-driven activity-based costing and compare the results with Medicare reimbursement and relative value units (RVUs).

METHODS AND MATERIALS: Process maps were created to represent each step of prostate radiotherapy treatment at our institution. Salary data, equipment purchase costs, and consumable costs were factored into the cost analysis. The capacity cost rate was determined for each resource and calculated for each treatment option from initial consultation to its completion. Treatment options included low-dose-rate brachytherapy (LDR-BT), combined high-dose-rate brachytherapy single fraction boost with 25-fraction intensity-modulated radiotherapy (HDR-BT-IMRT), moderately hypofractionated 28-fraction IMRT, conventionally fractionated 39-fraction IMRT, and conventionally fractionated (2 Gy/fraction) 23-fraction pelvis irradiation with 16-fraction prostate boost.

RESULTS: The total cost to deliver LDR-BT, HDR-BT-IMRT, moderately hypofractionated 28-fraction IMRT, conventionally fractionated 39-fraction IMRT, conventionally fractionated 39-fraction IMRT, and conventionally fractionated (2 Gy/fraction) 23-fraction pelvis irradiation with 16-fraction prostate boost was $2719, $6517, $4173, $5507, and $5663, respectively. Total reimbursement for each course was $3123, $10,156, $7862, $9725, and $10,377, respectively. Radiation oncology attending time was 1.5−2 times higher for treatment courses incorporating BT. Attending radiation oncologist's time consumed per RVU was higher with BT (4.83 and 2.56 minutes per RVU generated for LDR-BT and HDR-BT-IMRT, respectively) compared to without BT (1.41−1.62 minutes per RVU).

CONCLUSIONS: Time-driven activity-based costing analysis identified higher delivery costs associated with prostate BT compared with IMRT alone. In light of recent guidelines promoting BT for intermediate- to high-risk disease, re-evaluation of payment policies is warranted to encourage BT delivery.

Keywords:: Prostate; Cost; HDR; LDR; IMRT; TDABC

Introduction

Prostate cancer has a high prevalence among men and can be effectively managed by a number of treatment modalities (1, 2). For patients who undergo radiation therapy, brachytherapy (BT), external beam radiation therapy (EBRT), or a combination of the two with or without androgen deprivation therapy (ADT) are standard treatment options, with variations based on risk stratification (3−5). BT involves the placement of radioactive sources directly

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into the prostate using an ultrasound-guided transperineal approach, with either permanent seeds (low-dose-rate brachytherapy [LDR-BT]) or a temporary implant (high-dose-rate brachytherapy [HDR-BT]) (6, 7). LDR monotherapy is an option for low-risk disease, as well as for selected patients with intermediate-risk prostate cancer (7). Combination therapy with BT and supplemental EBRT is offered for patients with intermediate- and high- risk prostate cancer, for whom risk of microscopic extracapsular extension warrants more aggressive coverage (6–8).

Recently reported results from the Androgen Suppression Combined with Elective Nodal and Dose Escalated Radiation Therapy (ASCENDE-RT) trial showed that intermediate- and high-risk patients experienced improved biochemical progression-free survival with EBRT plus LDR-BT boost, compared with dose-escalated EBRT alone (9). Other trials have been performed comparing EBRT with HDR-BT boost to EBRT alone and show improved biochemical control with combination therapy compared with EBRT alone. However, these studies show a trend to higher genitourinary toxicities after combination therapy compared with EBRT alone, with late severe genitourinary toxicities ranging from 4% to 31% across studies (10–14).

In light of the results of the ASCENDE-RT trial and other studies that suggest improved biochemical control when BT is added to EBRT, the American Society of Clinical Oncology (ASCO) and Cancer Care Ontario (CCO) issued joint guidelines in 2017 recommending that all eligible patients with intermediate- to high-risk prostate cancer be offered BT (15). However, despite the clinical advantages in incorporating BT into prostate cancer treatment, there has been an overall decline in utilization for both BT boost and monotherapy (16). Glaser *et al.* evaluated patterns of care in the National Cancer Data Base and observed a decline in use of BT boost in combination with EBRT (compared with dose-escalated EBRT alone) from 33% in 2004 to 12.5% in 2013 (17). The low rate of BT utilization is particularly concerning considering the recent ASCO/CCO guidelines that recommend that BT be offered to all patients with intermediate- and high-risk prostate cancer (18). Suggested hypotheses for this trend toward lower BT utilization include more patients undergoing radical prostatectomy, decreased BT training among radiation oncologists, or reimbursement trends (17).

In this study, we calculate the delivery costs and reimbursement of prostate cancer radiation therapy options to explore candidate contributors to the observed low rate of BT utilization in prostate cancer. We evaluate the delivery costs of standard definitive radiation therapy options for intermediate- and high-risk prostate cancer using time-driven activity-based costing (TDABC) methods. TDABC is a bottom–up accounting method described by Kaplan and Porter as a strategy to calculate the costs of delivering health care to support consideration of value (19). We compare TDABC findings with Medicare reimbursement rates and relative value units (RVUs) to provide a framework for considering different delivery costs and payments for the various treatment options. We hypothesize that this analysis may provide insights into the potential role of financial pressures as a driver of the observed decline in BT delivery in the treatment of prostate cancer radiation therapy.

Methods

Details of clinical management

Patients with intermediate- to high-risk prostate cancer are referred to our clinic for primary radiation therapy. At the time of initial radiation oncology consultation, each patient is evaluated for definitive therapy and is provided counseling regarding the overall plan of IMRT and/or BT. For the present study, it was assumed that the patient received one of the options delivered at our institution for intermediate- to high-risk cancer patients: LDR-BT monotherapy (125 Gy using ^{103}Pd); combination HDR-BT single-fraction 15 Gy boost with 45 Gy in 25-fraction intensity-modulated radiotherapy (HDR-BT-IMRT); moderately hypofractionated IMRT consisting of 70 Gy in 28 fractions (HypoFx-IMRT), conventionally fractionated 78 Gy in 39 fractions IMRT (Std-IMRT), or conventionally fractionated 46 Gy in 23-fraction pelvis irradiation with 32 Gy in 16-fraction prostate boost (Pelvis-IMRT). Although ADT is added to radiation therapy in many instances, our analysis does not include ADT delivery costs because the analysis focuses on radiation therapy modalities and the delivery of ADT consumes little radiation oncologist time and no radiation therapy technical resources. Routine follow-up visits for surveillance and symptom management are not included in the analysis because they are performed at similar intervals for the different treatment options and therefore do not influence comparisons.

IMRT treatment planning is used for all patients who receive EBRT at our institution. Before the start of the IMRT course, patients undergo CT simulation for treatment planning and begin the treatment 5–7 work days later. Patients also undergo prostate–rectal spacer placement and a treatment planning MRI before CT simulation, but these components of care were excluded from the cost analysis. The physician team, which includes both attending physician and resident, creates, reviews, and approves contours of target volumes and organs at risk before treatment planning. An initial plan is developed to deliver the following: Std-IMRT to the prostate (including the lymph nodes with a cone down to the prostate for some patients); HypoFx-IMRT; or 45 Gy in 25 fractions if HDR-BT boost is used for a combination therapy approach. The physician then reviews and approves the plan before treatment delivery. Daily cone beam CT is performed for target localization before each IMRT fraction. During the IMRT treatment course, patients are evaluated weekly in clinic by a nurse and an attending physician.

Before LDR-BT, a procedure is carried out where nurse and physician provide counseling to the patient and a