Original Article

Utilizing Time-Driven Activity-Based Costing to Understand the Short- and Long-Term Costs of Treating Localized, Low-Risk Prostate Cancer

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BACKGROUND: Given the costs of delivering care for men with prostate cancer remain poorly described, this article reports the results of time-driven activity-based costing (TDABC) for competing treatments of low-risk prostate cancer. **METHODS:** Process maps were developed for each phase of care from the initial urologic visit through 12 years of follow-up for robotic-assisted laparoscopic prostatectomy (RALP), cryotherapy, high–dose rate (HDR) and low–dose rate (LDR) brachytherapy, intensity-modulated radiation therapy (IMRT), stereotactic body radiation therapy (SBRT), and active surveillance (AS). The last modality incorporated both traditional transrectal ultrasound (TRUS) biopsy and multiparametric-MRI/TRUS fusion biopsy. The costs of materials, equipment, personnel, and space were calculated per unit of time and based on the relative proportion of capacity used. TDABC for each treatment was defined as the sum of its resources. **RESULTS:** Substantial cost variation was observed at 5 years, with costs ranging from $7,298 for AS to $23,565 for IMRT, and they remained consistent through 12 years of follow-up. LDR brachytherapy ($8,978) was notably cheaper than HDR brachytherapy ($11,448), and SBRT ($11,665) was notably cheaper than IMRT, with the cost savings attributable to shorter procedure times and fewer visits required for treatment. Both equipment costs and an inpatient stay ($2,306) contributed to the high cost of RALP ($16,946). Cryotherapy ($11,215) was more costly than LDR brachytherapy, largely because of increased single-use equipment costs ($6,292 vs $1,921). AS reached cost equivalence with LDR brachytherapy after 7 years of follow-up. **CONCLUSIONS:** The use of TDABC is feasible for analyzing cancer services and provides insights into cost-reduction tactics in an era focused on emphasizing value. By detailing all steps from diagnosis and treatment through 12 years of follow-up for low-risk prostate cancer, this study has demonstrated significant cost variation between competing treatments. ***Cancer* 2016;122:447-55.** *© 2015 American Cancer Society.*

KEYWORDS: active surveillance, brachytherapy, cost analysis, prostate neoplasms, radical prostatectomy, radiotherapy, value-based purchasing.

INTRODUCTION

With an increased incidence of prostate cancer[1] and a 44% reduction in prostate cancer mortality after the adoption of prostate-specific antigen (PSA) testing,[2] the nationwide cost of prostate cancer care is substantial: it totaled $11.85 billion in 2010 and has been estimated to be $18.53 billion in 2020.[3] An array of treatment modalities currently exist, with clinical practice guidelines listing radical prostatectomy, external-beam radiation therapy, brachytherapy, and active surveillance (AS) as acceptable options for men with clinically localized cancer.[4] Although the treatment outcomes have been largely defined and long-term survival has been shown to be similar to that for low-risk disease, there has been less investigation into the overall cost of each approach. As health policy becomes more cost-conscious,[5,6] understanding the overall value of each approach, defined as the ratio of the quality of care to the cost of that care, now carries paramount importance.

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Although understanding the cost of producing services and products is a fundamental part of business management, accurately measuring health care costs remains a challenge. In traditional fee-for-service models, accountability for costs falls on the insurer because physicians and health systems are incentivized toward quantity rather than quality.[7] As a result, traditional accounting methods often involve significant cost shifting from low-reimbursing service lines to more profitable ones, and this obscures the true cost of any one structure. Furthermore, busy physician practices often lack the resources necessary to evaluate costs across services, focusing instead on more readily available data such as revenue or reimbursement.[8] Not surprisingly, Pate et al[9] found a range of $10,100 to $135,000 for the cost of radical prostatectomy for an insured patient, with most charges arbitrarily determined and influenced by insurance reimbursement. As society moves toward accountable care organizations and bundled payments as mechanisms to mitigate our growing health care expenditures, however, health systems must become proficient at systematically bending their cost curves.[10] The first step in accomplishing this goal is understanding costs on a detailed level.

Time-driven activity-based costing (TDABC) is a well-described costing paradigm used in a variety of industries.[11] When used in health care, it allows the actual expense of providing care to be calculated by aggregating costs over the full cycle of care for a patient's medical condition.[12] This cost is dependent on the actual use of resources involved in the care process and incorporates the proportion of time devoted by each resource as well as the cost of each resource per unit of time.[13] TDABC allows all personnel, equipment, facility, and support costs to be directly attributed to the organization's output of patient care, and it illuminates areas of inefficiency while highlighting opportunities for rational cost reduction.[14,15]

In this study, we describe our experience with TDBAC at an academic referral center to detail the costs of competing treatments for low-risk, localized prostate cancer from the initial urologic visit and prostate biopsy through 12 years of follow-up. We hypothesized that we would identify opportunities for cost reduction and value-based care redesign through the use of this approach.

MATERIALS AND METHODS

Process Map

To calculate the true costs for treating low-risk, localized prostate cancer, we implemented the TDABC method as previously described by Kaplan and Anderson at the Harvard Business School.[13] We assembled an expert team of stakeholders, including attending physicians, residents, nursing supervisors, operative services administrators, clinic administrators, and business analysts from urology, radiology, radiation oncology, and hospital operations, to develop step-by-step process maps of all the clinical and administrative processes routinely involved in delivering care for men with prostate cancer. For each treatment algorithm, given previously reported results of prolonged long-term survival among all treatment arms, we traced the episode of care for a patient with prostate cancer from the initial visit with a urologist at the University of California Los Angeles (UCLA) for elevated PSA levels through 12 years of follow-up (Fig. 1).[16] All care, such as prostate biopsy, was considered to be performed at UCLA specifically, and follow-up consisted of the following algorithm: quarterly PSA checks and physical examinations for the first 2 years, biannual PSA and physical examinations through 5 years, and annual PSA and physical examinations thereafter.

Defining the Intervention

The specific interventions analyzed followed the American Urological Association practice guidelines[4] and were the most commonly used at our institution for treating localized, low-risk prostate cancer. These included robotic-assisted laparoscopic prostatectomy (RALP), high–dose rate (HDR) and low–dose rate (LDR) brachytherapy, intensity-modulated radiation therapy (IMRT), stereotactic body radiation therapy (SBRT), and AS. We also included cryotherapy because it is routinely performed both at UCLA and across the United States.[17] Given no universally defined protocol for AS, we used the established protocol at our institution, which included biannual PSA and physical examinations and annual multiparametric magnetic resonance imaging (mp-MRI)/transrectal ultrasound (TRUS) fusion biopsies with the UroNav platform (Invivo Corporation, Gainesville, Fla). Either conventional TRUS or mp-MRI/TRUS fusion biopsy was used for the initial diagnosis, and costs were based on the ratio of each performed.

Next, we quantified the time spent to perform specific tasks. For treatments typically performed in the operative room, we obtained operative times based on anesthesia estimates for cases performed from March 2013 through May 2015 (RALP [65 cases], HDR brachytherapy [90 cases], LDR brachytherapy [6 cases], and cryotherapy [14 cases]). To estimate the mean length of the procedure for SBRT, IMRT, mp-MRI/TRUS fusion

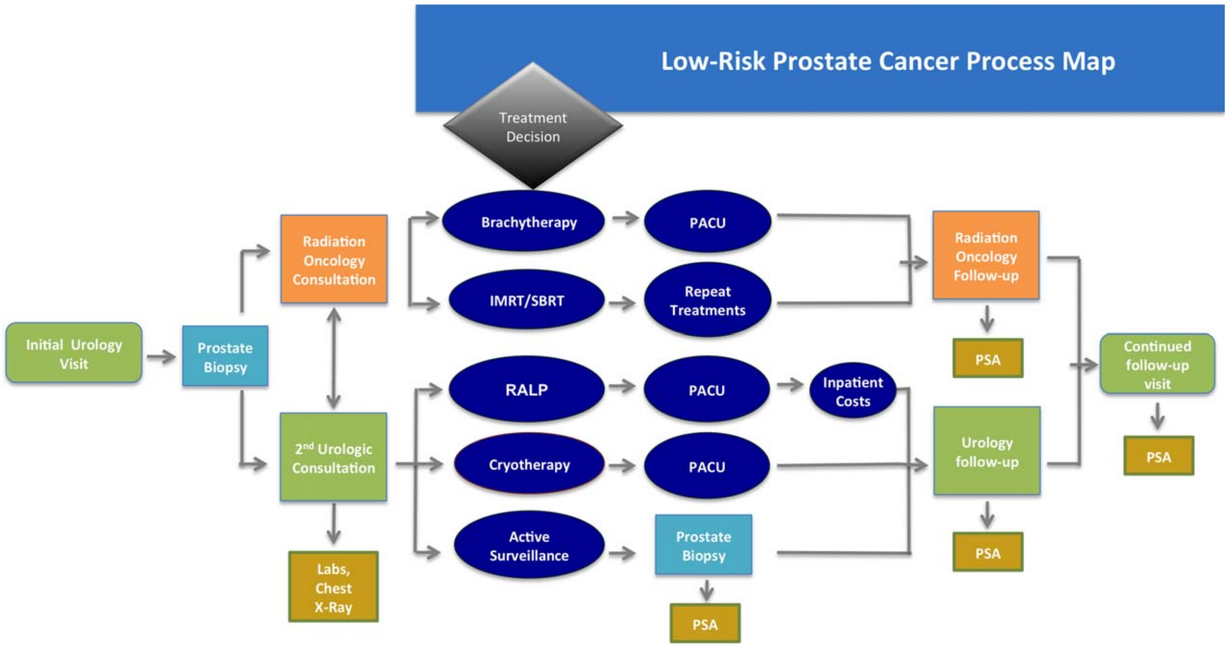

Figure 1. Macroscopic view of the process map outlining the major steps involved in treating localized, low-risk prostate cancer from the initial urology visit through 12 years of follow-up after the intervention. EBRT indicates external-beam radiation therapy; PACU, postanesthesia care unit; PSA, prostate-specific antigen; RALP, robotic-assisted laparoscopic prostatectomy.

biopsy, and conventional TRUS-guided biopsy, independent researchers timed at least 10 of each of these procedures. Next, we developed detailed process maps to highlight each step and resource involved in treatment. Figure 2, for example, demonstrates the steps involved in the treatment planning phase for HDR brachytherapy. To calculate the time to complete each step, we timed the observed action directly or interviewed those involved and averaged the minimum and maximum times to complete that step.

Estimating the Capacity Cost Rate and Price per Unit of the Resource

The capacity cost rate, or amount used per minute, was determined for every resource involved in the process maps. This included materials (eg, price per minute for the robotics operative table), personnel (eg, price per minute for the dosimetrist to contour targets), and space (eg, price per minute to rent the brachytherapy suite). The numerator in the capacity cost rate equation consisted of the total costs accrued for the space, personnel, materials, and equipment. Personnel costs included the direct cost of salary and the indirect costs of benefits, administrative support, office expenses, training, travel, information technology, and malpractice insurance when relevant. Physician salaries, which are publicly available, were averaged according to the percentage of cases performed by that physician for that particular treatment (6 urologists, 4 radiation oncologists, and 2 radiologists). Because physicians at UCLA have various salary contracts ranging from full-time equivalent contracts to relative value unit–based contracts, these estimates reflect a blend of the different contractual agreements. Equipment costs included the direct cost as well as the costs of maintenance, depreciation, and repair when applicable. Clinic administrators, faculty, and materials management determined the lifespan of each instrument and how often parts were reordered; this allowed the costs of depreciation and maintenance to be determined. Finally, clinic and hospital space costs were obtained from departmental and health system administrations, respectively. Blue prints were obtained to determine the square footage of every room devoted to treating patients with prostate cancer, and a proportionate percentage of the monthly rent was then determined for each area.

The denominator of the capacity cost rate equation included the available capacity of every resource available for productive work (measured in minutes). With personnel, we used the entire calendar year but factored in time unavailable because of vacations, breaks, weekends, and continuing education requirements. We estimated that attending surgeons worked 10.5 hours per day, including work from home, and this gave them an estimated personnel capacity of 137,469 minutes.[18] Finally, the capacity

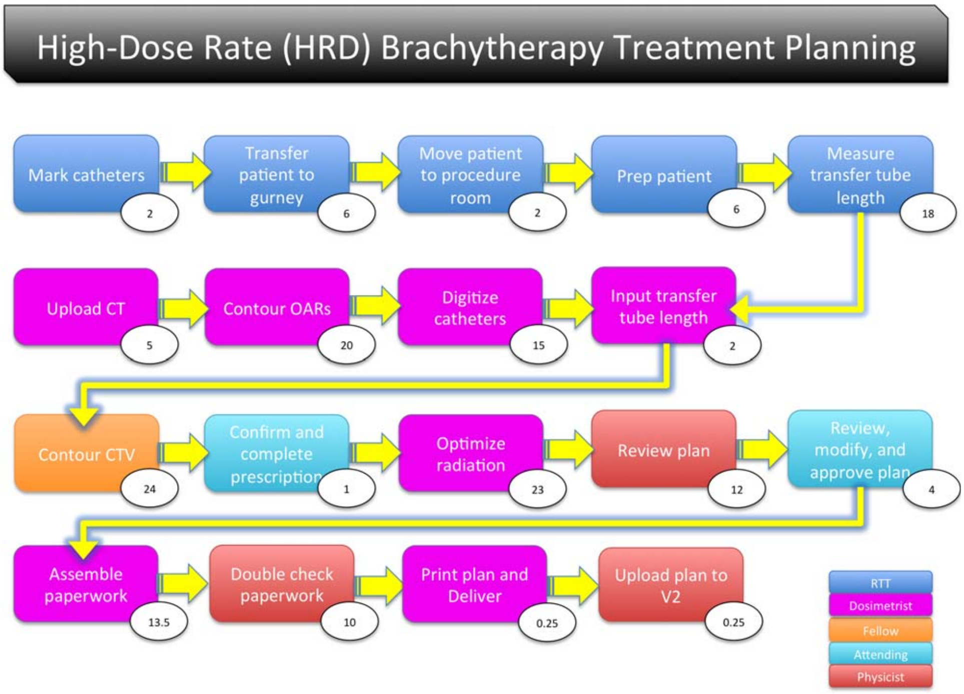

Figure 2. Step-by-step process map of all clinical and administrative steps involved in the treatment planning phase for HDR brachytherapy. The median time for each step is shown in the circles. CT indicates computed tomography; CTV, clinical target volume; HDR, high–dose rate; OAR, organ at risk; RTT, radiation therapy technologist; V2, microselection V2 high–dose rate.

cost rate of every resource was calculated by the division of the complete costs of supplying a resource by its available or functional capacity.

Deriving Total Costs to Compare Treatment Interventions

To determine the total cost to the health system for caring for a patient from diagnosis through intervention and 12 years of follow-up, we multiplied the mean time spent on every resource in the process map by its capacity cost rate and the probability that the event would occur (eg, the percentage of the time that conventional TRUS biopsy was performed). Single-use, disposable instrument costs were included in the algorithm when relevant. The summation of the cost of each process step in the treatment pathway resulted in the total cost of care for each intervention. We then compared the total costs to one another. The institutional review board deemed this study exempt from review.

RESULTS

Across the spectrum of care for low-risk prostate cancer, there was substantial variation in cost, which ranged from $7,298 for AS to $23,565 for IMRT at 5 years of follow-up (Table 1). Radiation costs varied considerably because of the number of treatments delivered and the fixed costs of the equipment. For example, although the costs of each treatment session were similar for SBRT and IMRT ($479 and $298, respectively), the total number of treatments (5 vs 45) largely drove the differences in cost at 5 years ($11,665 vs $23,565). A further breakdown of the cost of each process for IMRT and its relative contribution to the overall cost is shown in Table 2. Similarly, LDR brachytherapy was cheaper than HDR brachytherapy ($8,978 vs $11,448), largely because of the number of treatments (1 vs 2), the shorter total procedure time (99.5 vs 150.7 minutes, $P < .0001$), and the comparable costs between treatment sessions ($3,888 for LDR vs $4,000 for HDR treatment 1 and $3,956 for HDR treatment 2).

Disposable costs were significant and contributed $1,921 and $2,296 to the cost for LDR and HDR brachytherapy, respectively. Among these material costs, the iodine-125 permanent seeds accounted for 75.6% of the material expenditures for LDR brachytherapy, and the Flexi-Needles (Best Medical International, Springfield, Va) accounted for 20.0% of these costs for HDR brachytherapy.

RALP was the second most expensive modality at $16,946 at 5 years, with its most significant costs fueled by equipment costs and an inpatient stay, which was

TABLE 1. Total Costs of Competing Treatments for Localized, Low-Risk Prostate Cancer From the Initial Urologic Consultation Through 5 Years of Follow-Up

Treatment	Cost (US $)
Active surveillance	$7,298
LDR brachytherapy	$8,978
Cryotherapy	$11,215
HDR brachytherapy	$11,448
SBRT	$11,665
Robotic prostatectomy	$16,946
IMRT	$23,565

Abbreviations: HDR, high–dose rate; IMRT, intensity-modulated radiation therapy; LDR, low–dose rate; SBRT, stereotactic body radiation therapy.
This model was based on the assumption that 50% of the patients underwent standard transrectal ultrasound, 50% underwent magnetic resonance imaging fusion transrectal ultrasound biopsy, every patient followed up with urology before referral to radiation oncology, and patients had quarterly visits postoperatively for 2 years followed by biannual visits through 5 years of follow-up.

TABLE 2. Detailed Cost Breakdown for IMRT Highlighting the Cost of Each Process Step and Its Relative Contribution to the Overall Cost

IMRT Process Step	Cost (US $)	Relative Cost (%)
Initial urology visit	$101	0.4
Prostate biopsy	$650	2.8
Second urologic consultation	$190	0.8
New patient: radiation oncology	$544	2.3
Simulation	$1,048	4.5
Treatment planning	$2,686	11.4
Treatment	$13,608	57.8
On-treatment visit	$788	3.3
Initial follow-up visit	$142	0.6
Quality assurance		
Daily	$2,052	8.7
Monthly	$57	0.2
Yearly	$254	1.1
Year 1 follow-up visits with PSA	$413	1.8
Year 2 follow-up visits with PSA	$413	1.8
Year 3 follow-up visits with PSA	$207	0.9
Year 4 follow-up visits with PSA	$207	0.9
Year 5 follow-up visits with PSA	$207	0.9
Total	$23,564	

Abbreviations: IMRT, intensity-modulated radiation therapy; PSA, prostate-specific antigen.
*% does not add exactly to 100% due to rounding

estimated at 1.28 days (mean cost, $2,306; n = 65). Total operative costs were $11,839: 83.2% ($9,855) were fixed costs attributable to staff, space, equipment purchase fees, and depreciation/maintenance, and 16.8% ($1,984) were disposable costs from the robotic instruments. The operative time was estimated at $37.63 per minute. Cryotherapy was the fifth most expensive modality at $11,215, with disposable equipment responsible for the majority of the costs at 56.1% ($6,292). The high disposable instrument costs resulted from using per-case cryotherapy kits from an outside vendor rather than individually purchasing the equipment; this was preferred because of the paucity of cases. Nevertheless, the lack of inpatient admission made this modality significantly cheaper than RALP.

In contrast to the other interventions, AS at 5 years was the cheapest modality (estimated at $7,298). Initial biopsies were equally split between conventional TRUS (50%) and mp-MRI/TRUS fusion (50%), whereas all biopsies thereafter were considered mp-MRI/TRUS fusion. Conventional TRUS biopsy was notably cheaper than mp-MRI/TRUS fusion ($270 vs $1,072), with MRI constituting 62.5% (or $670) of the cost for the latter. The MRI costs involved personnel and equipment, the time for image interpretation, and the costs of creating and transferring the image to a picture archiving and communication system. Because of the relatively short time to perform the fusion biopsy (30 minutes), personnel and space costs made up $298 (or 27.8%) of the overall cost of biopsy, whereas equipment costs for the UroNav and MRI constituted most of the remainder ($774 or 72.2%). When costs were compared for every year of follow-up between modalities, the cost of AS was 13.9% of the cost of RALP at year 1 but was 91.7% of the cost at year 12, assuming annual biopsies. Cost equivalency was reached by year 7 for AS and LDR brachytherapy and by year 9 for AS and SBRT, cryotherapy, and HDR brachytherapy. The cost of each modality per year of follow-up is displayed in Figure 3. Finally, because up to 50% of patients opt out of AS, a sensitivity analysis was performed under the assumption that 100 patients start on AS and 50 of them convert to definitive therapy by year 5 (Fig. 4). If 50% switch to RALP by the 5th year, the cost is $14,619 for delayed RALP versus $16,946 for immediate treatment. Cost equivalence in this model is reached at year 7, with the cost of immediate RALP estimated at $17,152 versus $17,162 for delayed treatment (this assumes that 50% remain on AS for 6 years and then switch to RALP).

DISCUSSION

With numerous treatment modalities currently available for prostate cancer and notable long-term survival regardless of intervention, the individual value of each treatment cannot be defined until we have a better understanding of the true cost of care.[19,20] This includes not only the diagnostic and in-hospital costs but also the cost of care over time. Unfortunately, current costing mechanisms lack transparency and can appear arbitrary. This can be especially important in the case of uninsured patients, who face large and hard-to-predict hospital and physician bills.

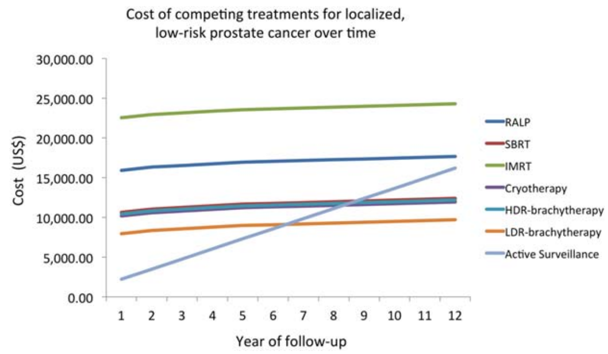

Figure 3. Cost of active surveillance versus competing treatments over time. At 7 years of follow-up, active surveillance reaches cost equivalence with LDR brachytherapy if we assume annual biopsies with magnetic resonance imaging fusion technology. By 10 years of follow-up, cost equivalence is reached with every treatment modality other than RALP and IMRT. HDR indicates high–dose rate; IMRT, intensity-modulated radiation therapy; LDR, low–dose rate; RALP, robotic-assisted laparoscopic prostatectomy; SBRT, stereotactic body radiation therapy.

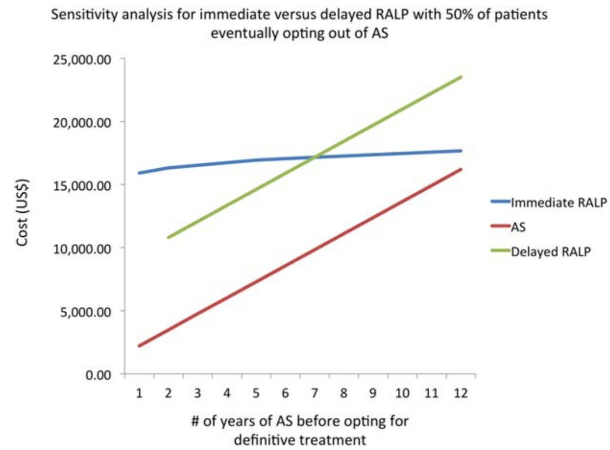

Figure 4. Sensitivity analysis detailing the costs of immediate treatment versus deferred treatment for RALP. If 50% of patients opt out of AS by year 5, delayed treatment remains cheaper than immediate treatment, with cost equivalency reached around year 7. AS indicates active surveillance; RALP, robotic-assisted laparoscopic prostatectomy.

Altogether, our study is the first to describe TDABC for competing treatments of localized, low-risk prostate cancer, and it has several important findings.

First, the implementation of TDABC to understand the short- and long-term economic burden of treating localized, low-risk prostate cancer is feasible. Although previous studies have correlated hospital charges with cost and used subjective estimates of how and where people spend their time,[21] TDABC's methodology evaluates costs at the specific resource level and allows further examination of the relative contributions of materials, personnel, and space toward each task. TDABC may improve the return on investment in health care and facilitate a sustainable health care system.[22] As our health care system continues toward bundled payments for medical subspecialties, including oncology, the onus to analyze costs and reduce inefficiencies will continue to be shifted to the providers. This infrastructure provides analytic data to improve the organizational structure of clinical departments and reduce waste. In addition, this infrastructure has the ability to transcend multiple service lines across an institution and greatly improve its economy of scale. For instance, because inpatient hospital processes and material usage are similar between RALP and robotic-assisted laparoscopic partial nephrectomy, we are reusing some inpatient cost data from the current project to determine the costs of care for treating small renal masses.

Second, despite numerous advances, robotic technology continues to be expensive over the long term, with total costs approximating $16,946 and $17,669 at 5 and 12 years of follow-up, respectively. This has important implications because the introduction of robotic technology into the treatment of prostate cancer has been credited with an increase in the use of surgery for men with localized disease.[23] Previous reports estimating the cost of RALP provided estimates lower than our estimates; they ranged from $6,752 to $10,804.[24-26] These costs, however, were based on hospital charges and included neither purchase and maintenance fees nor salaries. In addition, our study estimates the robotic operative time to be $37.63 per minute, which is notably higher than the estimates of $15 to 20 per minute obtained by other costing methods that do not consider the purchasing costs of robotic equipment, anesthesia costs, operating staff salaries, or the capacity cost rate for each resource.[27,28] In essence, every minute in the operating room counts, especially for a procedure in which differences in the operative time can vary by 42 minutes as a product of physician experience and volume.[29] Increased operative time is also associated with increased infectious complication rates and lengths of stay, which may further increase costs.[30] Efforts to streamline inefficient operative times are warranted.

Third, our data demonstrate significant variations in care for both radiation and brachytherapy depending on the type of treatment delivered (SBRT vs IMRT and HDR vs LDR brachytherapy). With respect to radiation therapy, our reported costs of $10,632 and $22,532 for SBRT and IMRT, respectively, at 1 year of follow-up are similar to those reported by others using Medicare claims

($13,645 and $21,023, respectively.)[31] Although some studies have suggested increased genitourinary toxicity for higher dose fractionated SBRT, others have projected a benefit in quality-adjusted life years for SBRT over IMRT.[32] Given we found SBRT to be less expensive than IMRT, it may result in better health care value; this will depend on outcomes. Finally, because of the potential value proposition, the comparative evaluation of SBRT and IMRT as well as other treatment modalities may be of great interest moving forward.

Fourth, similarl to our findings for external-beam radiation therapy, brachytherapy treatments differed widely in cost because of the differences in the number of treatments for HDR and LDR brachytherapy. Previous outcome studies have shown similar biochemical recurrence rates for HDR and LDR brachytherapy, although impotence, urinary frequency, and dysuria may be more profound with LDR brachytherapy.[33] The improvement in cost with a shorter treatment regimen must be weighed against the potential for more side effects and the costs of additional interventions. Our costs are notably more than previous estimates of $5,467 and $2,395 for HDR and LDR brachytherapy, respectively, but these latter costs excluded consultations, imaging, and laboratory studies and were derived from *Current Procedural Terminology* codes rather than exact metrics.[34] Furthermore, our data incorporated the cost of involving radiation oncology and anesthesia residents. How these costs vary in nonteaching hospitals with presumably shorter operative times remains to be studied. Future studies must also incorporate the cost difference of real-time ultrasound versus CT for treatment planning, as is routinely performed at certain centers.

Fifth, our study helps shed light on the overall value of mp-MRI/TRUS fusion biopsy, a technology championed for its potential role in more accurately identifying and classifying men with prostate cancer.[35] Our findings demonstrate costs of approximately $1,072 per fusion biopsy, whereas the cost of AS overall at 5 years is $7,298. Despite greater upfront costs, previous analyses have suggested that the incorporation of mp-MRI/TRUS fusion biopsy is cost-effective when the sensitivity of MRI guided biopsy is $\geq$20%.[36] Furthermore, at referral centers, mp-MRI/TRUS fusion biopsy has been shown to improve the detection of clinically significant prostate cancer, and it potentially classifies patients more appropriately for AS versus active treatment.[37] mp-MRI/TRUS fusion biopsy also may allow tracking of the index lesion in a patient on AS and allow more accurate detection of a stage shift.[38] These potential benefits must be weighed against the additional costs of the technology in the long term for patients on AS. Nevertheless, the costs of MRI may decrease if new pulse sequences can obviate the use of contrast. Our estimate of $690 for MRI is notably cheaper than the average reported cost of $2,611 based on 2013 charge data from the Centers for Medicare and Medicaid Services.[39] Clarification of this discrepancy could help consumers who are at risk for more of their health care expenditures, especially as costs continue to change. In addition, with no standardized guidelines for the long-term use of AS available, the frequency of biopsy and MRI may decrease over time. For instance, if MRI and biopsy are performed only every other year, the estimated cost of AS is $5,155 and $9,767 at 5 and 12 years, respectively, versus $7,298 and $16,199 with annual biopsies. Future studies will need to focus on the ideal frequency of biopsy in AS over time to determine which regimen minimizes costs without compromising outcomes. Our model is the first step toward clarifying its potential overall value.

Finally, the TDABC infrastructure creates a framework that efficiently enables institutions to champion value-based care redesign. Providers and organizations may use this framework to identify areas of inefficiency and increased costs that are not linked to improved outcomes or quality and thus eliminate waste. For example, our next step will be to link these results to rigorously assessed quality measurements and outcome trials for HDR and LDR brachytherapy, IMRT and SBRT, and various AS nomograms to see which treatments provide the greatest value at our institution. Furthermore, by focusing on relative resource consumption, TDABC allows cost analysis and insight that otherwise may be missed via traditional costing mechanisms. For instance, the treatment planning aspect of SBRT costs $2,686, yet patient-specific quality assurance by the physicist constitutes 53.3% of these costs. Streamlining these processes while not compromising patient satisfaction, quality, or safety may lead to significant cost savings.

Our study must be interpreted within the context of its design. First, our cost analyses were constructed from a single tertiary-care institution, and thus our findings may not be generalizable to the community setting. Costs will inevitably vary between health systems according to their structural organization, provider mix, patient population, and other locoregional idiosyncrasies. By creating an algorithm to help target reform initiatives, we hope that other health care systems will conduct similar studies to assess their cost trends and find ways to efficiently improve costs. Second, to calculate the capacity cost rate for each resource, the time taken to complete each activity was directly measured and sampled by an observer when exact time data were unavailable. Although mean times were taken, this does not account for the patients who may have been outliers in several of these steps. Third, our TDABC metric considers costs from the viewpoint of the hospital system and does not take into account various insurance reimbursement plans or the indirect costs to the patient, including convalescence, anxiety, and the associated costs of complications.[40] For example, although the relative costs of AS approach those of active treatment over time, a different trend may emerge when we consider less frequent biopsies or the costs of treatment side effects, including those for incontinence and impotence. Fourth, this cost analysis focuses on low-risk prostate cancer rather than including all localized disease. We kept this focus because low-risk prostate cancer is often treated with monotherapy, whereas multimodal approaches are frequently used for intermediate- and high-risk disease.[41] In addition, AS has been shown to exhibit decreased efficacy for intermediate- and high-risk disease.[42] Future studies should include building decision analytic trees to assess the total cost of care for all localized prostate cancer. Fifth, it has been well documented that 30% to 50% of individuals placed on AS eventually opt for definitive therapy over time,[43,44] and this will potentially increase the true costs of AS. As a result, we performed a sensitivity analysis investigating the cost of care at 5 years if 50% of patients on AS eventually opt for RALP. These results show that delayed RALP is still cheaper at 5 years if 50% opt out of AS ($14,619 for delayed treatment versus $16,946 for immediate treatment), with cost equivalency reached at 7 years. With similar outcomes for immediate and delayed treatment, this further supports the value of AS in appropriately selected patients. Finally, to understand the true value to our health care system for each of these modalities, TDABC costs must be linked to patient experience, quality of life, and oncologic outcomes. Nevertheless, our study is the first step toward introducing clarity into the cost enigma of prostate cancer care and will hopefully stymie the large variation in pricing currently seen.

In conclusion, as health care redesign continues to emphasize value-based care, we have incorporated a novel costing strategy, TDABC, to assess the total costs of treating localized, low-risk prostate cancer from diagnosis through 12 years of follow-up. We have demonstrated significant cost variation between competing treatments, with costs ranging from $7,298 for AS to $23,565 for external-beam radiation therapy at 5 years. Our cost estimate for RALP was higher than previously reported because we included purchase and maintenance fees, physician salaries, and the increased cost of the operating room. We found notable cost variation among external-beam radiotherapy and brachytherapy approaches, which was mainly attributable to the number of treatments required. Altogether, TDABC is a feasible and powerful method for informing value-based care redesign.

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CONFLICT OF INTEREST DISCLOSURE

The authors made no disclosures.

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