Comparative Effectiveness Research/Health Technology Assessment

Comparative Effectiveness, Cost, and Utilization of Radical Prostatectomy among Young Men within Managed Care Insurance Plans

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ABSTRACT

Background: Costs and benefits of emerging prostate cancer treatments for young men (age < 65 years) in the United States are not well understood. We compared utilization, clinical outcomes, and costs between two types of radical prostatectomy (RP)—minimally invasive prostatectomy (MIRP) and retropubic prostatectomy (RRP)—among young patients.

Methods: We extracted from LifeLink Health Plan Claims Database, a commercial claims database, information on 10,669 patients receiving either MIRP or RRP between 2003 and 2007. In unadjusted analyses, we used chi-square tests to compare clinical outcomes and nonparametric bootstrapping method to compare costs between the MIRP and RRP groups. We applied logistic, Cox proportional hazard, and extended estimation equation methods to examine the association between surgical modality and perioperative complications, anastomotic stricture, and costs while controlling for age, comorbidity, and health plan characteristics.

Results: The percentage of prostatectomies performed as MIRP increased from 5.7% in 2003 to 50.3% in 2007. Patients with more comorbidity were more likely to undergo RRP than MIRP. Compared with the RRP group, the MIRP group had a significantly lower rate of perioperative complications (23.0% vs. 30.4%; P < 0.001) and a lesser tendency for anastomotic strictures (hazard ratio 0.42; 95% CI 0.35–0.50) within the first postoperative year but had higher hospitalization costs ($19,998 vs. $18,424; P < 0.001) despite shorter hospitalizations (1.7 days vs. 3.1 days; P < 0.001). Similar findings were reported in the subgroup analysis of patients with comorbidity score 0.

Conclusion: MIRP among nonelderly patients increased substantially over time. MIRP was found to have fewer complications. Lower costs of complications appeared to have offset higher hospitalization costs of MIRP.

Keywords: cancer, claims databases, cost analysis, managed care, minimally invasive surgeries.

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Introduction

The decision of a patient with prostate cancer to pursue radical prostatectomy (RP), radiation therapy, or active surveillance constitutes a complex interplay of the preferences and risk tolerance of the patient and his physician. The treatment strategy is further complicated by the paucity of scientific information with which to compare a growing list of emerging surgical options. Better treatment guidelines have been hampered by a lack of randomized clinical trials or incomplete prospective comparative trials. Non-standardized metrics of treatment response and quality-of-life outcomes across studies have further muddled the decision-making process. This uncertainty among providers and consumers has catalyzed marked variability in prostate cancer treatments across the country.

Given the lack of randomized controlled trials to provide definitive answers for this most commonly diagnosed cancer in males [1], costs associated with various treatment options are likely to become increasingly important in the decision-making process. More than 75,000 prostatectomies are performed annually in the United States [2]. The estimated cost for the first 6 months of prostate cancer treatment is in the range of $13,000 to $17,000 (2002 US dollars) for elderly patients treated with RP [2,3]. Since that time, a number of emerging technologies have been introduced. Minimally invasive RP (MIRP), such as robotic-assisted or standard laparoscopic RP, has become one of the most popular forms of primary prostate cancer therapy. Between 2003 and 2005, the proportion of Medicare beneficiaries with newly diagnosed prostate cancer who underwent MIRP increased from 12.2% to 31.4% among those who received RP whereas patients undergoing retropubic RP (RRP) declined from 82% to 66.1% [4]. A similar trend has also been reported in studies including prostate cancer patients of all ages [5,6]. No study, however, has focused exclusively on patients younger than 65 years. This age group is of special importance, as an...
earlier study showed that despite a decline in RP among elderly patients, surgical treatment continued to increase among younger patients[7]. In addition, no population-based study has explored the impact of MIRP on the cost of prostate cancer care.

The objectives of this study are: 1) to understand the utilization patterns of the two most commonly used surgical approaches to RP—MIRP and RRP—from 2003 to 2007 among a cohort of young men (age < 65 years) with prostate cancer and enrolled in managed care plans; and 2) to compare the differences in outcomes and costs between patients treated with MIRP and those with RRP.

Methods

Study population and identification of RP modalities

By using the LifeLink Health Plan Claims Database, a proprietary claims data, we identified men 18 years and older than 65 years who underwent RP from 2003 to 2007. The database represents approximately 55 million individuals from more than 95 managed care plans throughout the United States and contains information on enrollment records and on medical and prescription drug claims. All claims data can be linked to enrollment records via de-identified person identifiers. The institutional review board of the University of Texas MD Anderson Cancer Center exempted this study for approval.

We classified patients into different RP groups by using Current Procedural Terminology (CPT) codes: patients with prostate cancer with CPT codes 55840, 55842, and 55845 were classified as the RRP group, whereas those with CPT code 55866 were classified as the MIRP group. It should be noted that the CPT code for MIRP did not differentiate between laparoscopic and robotic RPs, and thus our data would not allow further stratification of the MIRP procedures. All patients were required to be continuously enrolled in the same health plan for at least 9 months, covering 6 months before RP (for calculating comorbidity score) and 3 months afterward (for tracking perioperative complications). The selection of a 3-month follow-up period was to facilitate comparisons of perioperative complications with a published study using the Medicare data to compare MIRP and RRP among the elderly patients[4].

Outcome measures

We compared perioperative complications, anastomotic strictures, and length of stays between patients in the MIRP and RRP
groups. Perioperative complications within 90 days of RP included cardiac, respiratory, or vascular events, wounds or bleeding, other genitourinary conditions, and miscellaneous medical or surgical events. We measured the occurrence of strictures within 1 year of the surgery because clinicians in our research team suggested that a 90-day interval would be too short to capture this event. We identified the above conditions and events by using the relevant International Classification of Diseases 9 (ICD-9) or CPT codes from inpatient and outpatient claims; these codes were based on previously published studies [4], with minor modifications to reflect recent changes in coding. Specific codes used to identify each clinical outcome from claims are summarized in Table 1.

Cost measures
The LifeLink Health Plan Claims Database collected three financial variables: CHARGE, PAID, and ALLOWED. CHARGE is the amount that was billed to a health plan, PAID is the amount actually paid by the plan for a service, and ALLOWED is the amount the plan allows for a specific service and includes the paid amount plus any cosharing (e.g., copay) from the patients. Our cost measure was based on ALLOWED, as this variable was considered most closely reflecting the burden of illness and thus recommended by the data vendor [8]. We compared costs between the MIRP and RRP groups at three time intervals, costs associated with the hospitalization for RP, and cumulative costs within the first 3 and 6 months after surgery, as well as costs of perioperative complications. The decision to extend our cost analysis to 6 months after surgery was driven by an observation from our preliminary analysis that the median time to stricture was beyond 3 months; therefore, a cost analysis limited to a 3-month follow-up period would grossly underestimate the cost impact of stricture. All cost estimates were normalized to 2010 US dollars by using the medical care component of the consumer price index.

Analysis
Statistical analyses included unadjusted and adjusted analyses. In the unadjusted analyses, we compared the clinical outcomes and costs between the MIRP and RRP groups by using Pearson chi-square tests and nonparametric biased corrected and accelerated bootstrapping method, respectively [9,10]. The nonparametric bootstrapping method is an accepted approach to calculate confidence intervals (CIs) for highly skewed data, such as medical cost data [9]. The 3- and 6-month costs included costs of managing complications and secondary interventions. The cost of hospitalization included costs incurred only during the admission for the prostatic surgical procedure. For anastomotic stricture, we obtained the median time to stricture from the Kaplan–Meier sur-
vival curve and tested the difference in the overall survival distribution between the two groups by using the log-rank test.

In the adjusted analyses, we employed logistic regressions to examine factors associated with the utilization of MIRP and to ascertain the association between MIRP and each type of perioperative complication; we reported the results in odds ratios (ORs) and associated 95% CIs. In this model, “time” was defined as days from the date of RP to the first appearance of stricture or the date of censoring. The data could be censored either because of reaching the end of our 1-year observational period for stricture or from loss of follow-up due to disenrollment of insurance after 3 months but within 1 year of surgery. To determine whether the use of proportional hazard model was appropriate, we tested the Cox proportionality assumption by using the score test based on scaled Schoenfeld residuals [11]. We analyzed the cost data by using the extended estimation equation method; this method is a recent developed econometric method to analyze the highly skewed medical cost data [12].

Covariates in the multivariate analyses included age, payer type, health plan type, comorbidity score, and time trend. We categorized age in four categories—18 to 50, 51 to 55, 56 to 60, 61 to 64—and dichotomized payer type as commercial versus noncommercial plans. The type of health plan included indemnity plan, HMO, preferred provider organization, point of service, and other plans. A comorbidity score was constructed for each plan, HMO, preferred provider organization, point of service, commercial plans. The type of health plan included indemnity type, health plan type, comorbidity score, and time trend. We included diagnosis codes from outpatient claims only if they appeared more than once either in claims that were at least 30 days apart or in inpatient claim. Patients with comorbidity score 0 were considered the “healthy” cohort, whereas those with comorbidity scores 1 and 2 or higher were patients with mild and moderate to severe health problems. Time trend was captured by a list of dichotomous variables for each calendar year (2003–2007) to control for changes over time. In analyses comparing the outcomes between MIRP and RRP, we included an additional binary variable indicating whether the patient had MIRP (MIRP = 1) or RRP (MIRP = 0).

In addition, we added a subgroup analysis that consisted of patients with zero comorbidity score. These patients, referred to as the “healthy subgroup” in the subsequent discussions, were chosen to better understand whether the observed difference between the RRP and MIRP groups may be driven by a difference in patients’ case mix. If the difference was indeed due to the difference in the case mix between patients in the RRP group and those in the MIRP group, we would expect to find a smaller difference between the two groups in the subgroup analysis.

We used SAS 9.2 (SAS Institute Inc., Cary, NC) for data management and STATA 10.1 (StataCorp LP, College Station, TX) for statistical analyses. All P values reported are two-sided; statistical significance is defined as P < 0.05.

Results

Our sample included 3144 men treated with MIRP and 7525 men treated with RRP between 2003 and 2007. The utilization trend of RP modalities shows a dramatic increase in MIRP, robotic-assisted or laparoscopic, increasing from 5.7% of all RPs performed in 2003 to 50.3% in 2007. The comparison of patients’ characteristics (Table 2) showed that compared with patients who underwent RRP, a significantly higher proportion of patients who underwent MIRP had commercial insurance, but a significantly lower proportion of them had a comorbidity score of 2 or higher. Table 3 reports findings from the multivariate logistic regression. Similar to the findings from the unadjusted analysis, the adjusted analysis shows no significant age effect, but significantly higher odds of receiving MIRP for patients with commercial insurance. It should be noted,
However, that although the difference observed between patients who had commercial insurance versus other types of payers was not statistically significant, it did not imply that the difference was clinically significant.

Compared with patients with indemnity plans, those in HMO, point of service, and preferred provider organization plans had 1.40 (95% CI 1.15–1.71), 1.38 (1.11–1.73), and 1.42 (1.15–1.75) times higher odds of receiving MIRP in the full sample and the OR was 1.46 (1.17–1.83), 1.44 (1.13–1.84), and 1.49 (1.18–1.88), respectively, in the analysis of the healthy subgroup. We chose the indemnity plans as the reference group in the regression analyses because compared with other types of health plans, indemnity plans were least restrictive in patients’ selection of providers and self-referals. Compared with patients whose comorbidity score was zero, the odds of receiving MIRP were significantly lower (OR 0.27; 95% CI 0.20–0.35) for those whose comorbidity score was 2 or higher.

The comparison of perioperative complications (Table 4) shows that the unadjusted overall complication rate was significantly higher among patients treated with RRP (30.2% vs. 23.0%; \( P < 0.001 \)). Compared with the RRP group, the MIRP group had significantly lower rates of respiratory (4.0% vs. 5.4%; \( P = 0.003 \)) and miscellaneous medical complications (6.0% vs. 8.2%; \( P = 0.001 \)). Similar conclusions were found in the healthy subgroup. The comparison of Kaplan–Meier curves (see Fig. 1A,B) for stricture shows that the overall distribution of the MIRP group was significantly different from that of the RRP group (\( P = 0.004 \) in the full sample and \( P < 0.001 \) in the subgroup). Consequently, the overall complication rate within 3 months of RP was significantly higher for pa-

### Table 4 - Perioperative complications, unadjusted.

<table>
<thead>
<tr>
<th>Perioperative complications</th>
<th>Full sample</th>
<th>Comorbidity score = 0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RRP (n = 7525)</td>
<td>MIRP (n = 3144)</td>
</tr>
<tr>
<td>Complications within 90 d of radical prostatectomy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cardiac</td>
<td>1.3%</td>
<td>1.2%</td>
</tr>
<tr>
<td>Respiratory</td>
<td>5.4%</td>
<td>4.0%</td>
</tr>
<tr>
<td>Vascular</td>
<td>2.3%</td>
<td>1.9%</td>
</tr>
<tr>
<td>Wound or bleeding</td>
<td>2.1%</td>
<td>1.9%</td>
</tr>
<tr>
<td>Genitourinary</td>
<td>4.3%</td>
<td>3.8%</td>
</tr>
<tr>
<td>Miscellaneous medical</td>
<td>8.2%</td>
<td>6.0%</td>
</tr>
<tr>
<td>Miscellaneous surgical</td>
<td>5.8%</td>
<td>5.1%</td>
</tr>
<tr>
<td>Overall (90 d)</td>
<td>30.2%</td>
<td>23.0%</td>
</tr>
<tr>
<td>Length of stay</td>
<td>3.1 (SD 2.6)</td>
<td>1.7 (SD 1.7)</td>
</tr>
</tbody>
</table>

MIRP, minimally invasive radical prostatectomy; RRP, retropubic radical prostatectomy.

* P value for median time to stricture was based on log-rank test and for length of stay was based on t test; all other P values were based on Pearson’s chi-square test.

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**Fig. 1** - Kaplan–Meier curve of time to anastomotic strictures for minimally invasive radical prostatectomy (MIRP) and retropubic radical prostatectomy (RRP): (A) full sample and (B) sample with comorbidity score 0.
patients treated with RRP (30.2% vs. 23.0%; P < 0.001). The adjusted analyses from logistic regressions or proportional hazard models yielded similar conclusions (see Fig. 2A,B). After controlling for patient age, comorbidity score, payer type, plan type, and time, results from logistic regression show that patients in the MIRP group had significantly lower odds of perioperative complications (OR 0.73; 95% CI 0.66–0.81), especially because of miscellaneous medical complications (OR 0.74; 95% CI 0.62–0.89). Similar findings were observed in the analysis of the healthy subgroup. Results from the Cox proportional hazard model following patients up to 12 months after RP show that the MIRP group had a significantly lower hazard ratio (HR) of stricture, both in the full sample (HR 0.42; 95% CI 0.34–0.50) and in the subgroup (HR 0.42; 95% CI 0.34–0.51).

Table 5 summarizes the difference in costs between patients in the RRP and MIRP groups. On average, the costs of hospitalization for RRP and MIRP were $18,424 and $19,998, respectively, whereas the 6-month cumulative costs were $21,914 and $22,837, respectively. Costs associated with hospitalization for RP was significantly higher for the MIRP group ($1574 in unadjusted analysis and $833 in adjusted analysis), despite a shorter length of stay reported for MIRP-related hospitalizations (3.1 days vs. 1.7 days; P < 0.001). The difference in cost between these two modalities diminished after a longer follow-up, from a difference of $1215 ($512–$1920) ($970; $214–$1727 in adjusted analysis) in the 3-month cumulative cost to $923 ($158–$1993) (−$8; −$952–$969 in adjusted analysis) in the 6-month cost, whereas the costs of complications were significantly higher for the RRP group in both unadjusted ($465; $55–$805) and adjusted ($432; $130–$733) analyses.

Discussion

MIRP, in the form of either robotic-assisted or laparoscopic procedures, is the surgical modality preferred by many patients because of the perceived benefit of smaller incisions, shorter hospital stays, quicker convalescence, and less use of postoperative analgesics [15,16]. The increasing popularity of MIRP has inspired many studies to use data from a single institution to compare clinical outcomes or costs between MIRP and RRP [16–19]. Before this study, the only population-based studies to examine the trend and compare patient characteristics and outcomes between these two modalities either focused exclusively on Medicare beneficiaries (65 years of age and older) [4,20] or included a mix of young and old patients [5,6]. Our study is the first population-based study to evaluate utilization and outcomes, and more important, to provide cost estimates of RRP versus MIRP, among young patients with prostate cancer.

Prostate cancer diagnosis in nonelderly men has increased dramatically since the introduction of prostate-specific antigen screening [21]. By using the Surveillance, Epidemiology, and End Results (SEER) data, Welch and Albertsen demonstrated distinct age-specific trends with little net change in diagnosis for men in their sixth and seventh decades of life, but a tripling of prostate cancer diagnosis among men of age 50 to 59 years (58.4–212.7 per 100,000; risk ratio [RR] 3.64) and a more than sevenfold increase among those younger than 50 years (1.3–9.4 per 100,000; RR 7.23) [21]. The age groups experiencing the dramatic increase in prostate cancer diagnosis are also the focus of this study.

A comparison of our findings and those from a recently published SEER-Medicare study [20] shows several interesting pat-
The rising utilization of MIRP observed among the elderly patients was also found among younger patients. Hu et al. reported an increase in the utilization of MIRP from 9.5% in 2003 to 39.9% in 2005 and then to 43.2% in 2006–2007 among Medicare beneficiaries who received RP and resided in the SEER regions. In comparison, we documented increases in the utilization of MIRP from 5.7% in 2003 to 26.9% in 2005 and then to 50.3% in 2007. Despite a higher rate of an initial uptake of MIRP among elderly patients with prostate cancer, MIRP became more widely diffused among younger patients between 2005 and 2007.

Second, both studies found that MIRP was associated with fewer perioperative complications and shorter hospitalizations than was RRP. These findings are in line with historical data on RRP and more recent studies that have reported a lower rate of strictures [22,23] and shorter hospitalizations [15,17,19,24,25] with the minimally invasive approach. Hu et al. did not conduct a formal cost analysis, although in one of their earlier studies using Medicare data [4], they hypothesized that the shorter hospitalizations and lower transfusion rates associated with MIRP may result in a cost advantage for that modality. This hypothesis was not supported by our cost analysis. Our finding of higher hospitalization cost of MIRP is consistent with other published cost studies [15,18,19,24,25]. Both Lotan et al. [25] and Anderson et al. [15] concluded that the higher cost of MIRP was primarily driven by higher equipment costs and longer operative time associated with this procedure. A unique contribution of our study is to provide an estimate of the costs of perioperative complications. We found that on average the complication costs per patient were more than $400 higher in the RRP group; this finding was consistent with the estimate of the costs of perioperative complications. We found that on average the complication costs per patient were more than $400 higher in the RRP group; this finding was consistent with the estimate of the costs of perioperative complications. We found that on average the complication costs per patient were more than $400 higher in the RRP group; this finding was consistent with the estimate of the costs of perioperative complications. We found that on average the complication costs per patient were more than $400 higher in the RRP group; this finding was consistent with the estimate of the costs of perioperative complications. 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the RRP and MIRP groups were also found among young patients, it is possible that the higher rate of complications in the RRP group was driven by the difference in clinical, racial, and socioeconomic compositions between the two groups. It is difficult to project the impact of the lack of surgical volume variable on outcomes because the volume–outcome relationship remained inconclusive. Although better outcomes have been observed among patients treated by high-volume surgeons [32,33], a recent study also reported that surgeon volume did not explain the difference in outcomes between RRP and MIRP [20]. It should be noted that despite their use of the propensity score method to balance the observed characteristics between the MIRP and RRP groups, Hu et al. [20] reported that findings from their adjusted analyses were similar to those from unadjusted analyses; therefore, it is possible that our finding may persist had we been able to control for the above covariates in our analyses.

The database used in our analysis allows better investigation of the association between insurance characteristics and the use of MIRP. The LifeLink Health Plan Claims Database collected information on payer type and health plan type. By dichotomizing the payer categories into commercial versus noncommercial payers, we were able to compare payers who are likely to have more generous insurance coverage versus those with less generous coverage as the noncommercial payers consisted of patients who were self-insured, held public insurance, or had unknown payer type. Therefore, if the purchase of costly capital equipment such as a robotic system would provide a financial incentive for physicians to promote robotic-assisted MIRP, patients with more generous insurance coverage were likely to be more attractive candidates. This might explain our finding of a higher OR associated with commercial plans. The variable of health plan type captures different degrees of restrictions that insurance plans placed on the selection of providers, with the indemnity plan being the least restrictive type. The higher odds of MIRP observed among patients in plans that are more restrictive than those in the indemnity plans could be an indication that the use of MIRP is more likely to be driven by physicians, rather than patients. If MIRP was patient driven, we would have observed lower odds of MIRP among patients in more restrictive plans because patients in the indemnity plans would have less barriers to seek out physicians who will perform MIRP.

In addition to the issue of favorable selection discussed above, this study has several other limitations. First, claims databases often lack detailed clinical information because they are generated for billing purposes. Although we were able to document a growing utilization of MIRP among nonelderly patients with lower comorbidty, we were not able to conclude definitively whether the majority of the increase was driven by patients with low-risk tumors. Second, we were not able to differentiate between laparoscopic RP performed with and without robotic assistance because both procedures share the same CPT code. Therefore, our study was not able to examine the extent to which the growing use of MIRP was associated with the recent expansion of robotic systems [28,34]. We plan to answer these questions when more recent data become available because a new ICD-9 procedure code (17.42) was added for a laparoscopic robotic-assisted procedure in October 2008.

Third, for the less common perioperative complication, our sample may not have sufficient power to detect the difference between the MIRP and RRP groups. This concern is especially relevant to the analysis of cardiac, vascular, and wound/bleeding complication among the healthy subgroup. Lastly, because of the proprietary nature of the LifeLink Health Plan Claims Database, neither provider identifier nor geographic information was available. Thus, we were not able to examine the impact of surgeon volumes on outcomes, nor were we able to account for the clustering effect of providers. Findings on geographic variations among elderly patients with RP were not consistent in the literature. A study based on Medicare claims data found no geographic variation in the utilization of RRP and MIRP [4], whereas another study using SEER-Medicare data reported a higher rate of MIRP in SEER regions with high-volume RP centers [20]. It is not clear whether a similar trend would persist among nonelderly patients with prostate cancer.

Despite these limitations, our study makes a unique contribution to the literature. It is the first population-based study of the utilization and cost of RP modalities exclusively among nonelderly men. Thus, our study offers an opportunity to contrast the pattern observed among elderly and nonelderly patients. More important, the observation of the increasing use of MIRP among nonelderly patients with lower comorbidity suggests various forces at play. This may include the conversion of patients from active surveillance or from other nonsurgical modalities to MIRP, direct-to-consumer advertisement from manufacturers, or a combination of all these.

Acknowledgments

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