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Hospitalization Costs for Radical Prostatectomy Attributable to Robotic Surgery

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Abstract

Background: With health technology innovation responsible for higher health care costs, it is essential to have accurate estimates regarding the differential costs between robot-assisted radical prostatectomy (RARP) and open radical prostatectomy (ORP).
Objective: To describe the total hospitalization costs attributable to robotic and open surgery for radical prostatectomy (RP).
Design, setting, and participants: Using a population-based cohort by merging the Nationwide Inpatient Sample (NIS) and the American Hospital Association (AHA) survey from 2006 to 2008, we identified 29 837 prostate cancer patients who underwent RP.
Interventions: ORP and RARP.
Outcome measurements and statistical analysis: The primary outcome was total hospitalization costs adjusted to year 2008 US dollars. Generalized estimating equations were used to identify patient and hospital characteristics associated with total hospitalization costs and to estimate costs of ORP and RARP adjusted for case mix and hospital teaching status, location, and annual case volume.
Results and limitations: Overall, 20 424 (68.5%) patients were surgically treated with RARP, and 9413 (31.5%) patients underwent ORP. Compared to ORP, patients undergoing RARP had shorter median length of stay (1 d vs 2 d; $p < 0.001$) and were less likely to experience any postoperative complications (8.2% vs 11.3%; $p < 0.001$). However, patients undergoing RARP had higher median hospitalization costs ($10 409 vs $8862; $p < 0.001$). After adjusting for patient and hospital features, RARP was associated with higher total hospitalization costs compared to ORP ($11 932 vs $9390; $p < 0.001$). Our results are limited by a study design using retrospective population-based data.
Conclusions: Despite RARP having lower complications and shorter length of stay than ORP, total hospitalization costs are higher for patients treated with RARP compared with those treated with ORP.

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1. Introduction

With US health care costs of $2.6 trillion in 2010 [1], there is greater scrutiny to critically examine different treatments for patient-centered outcomes and health care value. Comparative effectiveness research (CER) represents one way to appraise various treatments for relative differences in clinical outcomes to better inform treatment decisions

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for patients, physicians, and policymakers. An ancillary aim of CER is to help control the growth in health care spending [2], in particular for hospitalizations given the $814 billion annual expenditure and significant variations of surgical costs in the United States [1,3]. Other important drivers of higher costs include hospital complications and health technology innovation [4,5].

With prostate cancer (PCa) remaining the most commonly diagnosed, noncutaneous, male malignancy with 241 470 incident cases in 2011 [6], $12 billion are spent on this prevalent cancer each year in the United States [7]. CER is therefore applicable to PCa, given the rapid adoption of more costly technology innovations, such as robotic surgery and intensity-modulated radiation therapy, absent supporting level 1 evidence [8]. Since its introduction in 2000, robot-assisted radical prostatectomy (RARP) has been rapidly adopted, supplanting conventional open radical prostatectomy (ORP) to a large degree [8–10]. The benefits of RARP include decreased length of stay (LOS) and blood loss with concomitant diminished need for blood transfusions [10,11], although the differences in oncologic outcome have been mixed and, to date, the two different surgical approaches have not been rigorously evaluated by any clinical trials [11].

In this context, RARP may be subject to greater scrutiny, especially since robotic surgery may add approximately $1 billion annually in health care spending [12]. Previous studies suggest that the differential cost may range from $200 to $2000 between ORP and RARP [8,13–19]. However, these studies may not fully capture the cost differential since they either rely on single-institution series, or population-based data from Medicare beneficiaries, in which case the US Centers for Medicare and Medicaid Services (CMS) reimburses RARP at the same rate as ORP. Therefore, we sought to describe the incremental hospitalizations costs for patients undergoing radical prostatectomy (RP) attributable to robotic surgery using population-level data.

2. Methods

2.1. Study population

Data for all patients who underwent RP for PCa were generated by merging two data sources: the Nationwide Inpatient Sample (NIS) and the American Hospital Association (AHA) Annual Survey. The NIS represents the largest all-payer inpatient database in the United States and captures approximately 20% of all hospital admissions [20]. The AHA conducts an annual survey of a nationally representative sample of approximately 5000 hospitals in the United States [21]. To identify the analytic cohort, we used a similar methodology described previously from *International Classification of Disease Modification* 9th edition (ICD-9) codes from hospital claims data in the NIS from 2006 to 2008 [10,22]. We selected elective cases with a primary diagnostic ICD-9 code for PCa (185) and concomitant primary or secondary procedure codes for RP (60.5) from the NIS. We further limited our cohort by excluding pediatric patients ($n = 3$).

2.2. Patient and hospital variables

Patient variables included in our analysis were age, race, health insurance, median income by zip code, LOS, and year of surgery. Secondary diagnostic codes were used to define an Elixhauser comorbidity index [23]. We also evaluated hospital teaching status, location, region, and annual case volume as independent hospital-level variables. The unique hospital identifier was used to enumerate annual case-volume quartiles by average number of RPs performed.

Another clinical variable assessed in our analysis was postoperative complications. We used the NIS to define postoperative complications similar to previous population-based studies examining the comparative effectiveness of minimally invasive radical prostatectomy (MIRP) versus ORP [9,10]. Postoperative complications were assigned to the following categories: cardiac, respiratory, genitourinary, wound, vascular, and miscellaneous medical or surgical related complications.

To address the heterogeneity in using laparoscopic-specific procedure codes to accurately capture RARP, as done in previous studies [8,9], we elected to use the AHA survey variable regarding presence of a robot surgical system at each hospital to determine type of RP. All patients treated at hospitals with robotic surgery were assigned to RARP cases, while those treated at hospitals without robotic surgery were designated as ORP cases, based on previous studies suggesting strong penetration of RARP by presence of robotic surgery [13,14,24].

2.3. Statistical analysis

The primary outcome of this study was total hospitalization costs, which were estimated from the NIS cost-to-charge ratio and then adjusted to 2008 US dollars using the Consumer Price Index for major expenditures [25,26]. Bivariate associations of patient and hospital variables with ORP and RARP were tested by the Pearson chi-square test. Differences in median total hospitalization costs and LOS were tested by the Mann-Whitney rank-sum test. We then fit generalized estimating equation (GEE) models to assess whether RARP and ORP were associated with higher costs, adjusting for patient and hospital covariates and clustering of patients to the hospital level. To account for the skewed distribution of costs, we specified a gamma distribution and log link in the GEE models [27].

We also performed a sensitivity analysis among a subset of patients undergoing RP from October 2008 to December 2008 to test the validity of our assumption regarding hospital presence of robotic surgery and receipt of RARP. With an ICD-9 code (17.4x) specific for robotic surgery introduced in October 2008, a primary diagnostic code for PCa and concomitant procedure codes for RP and robotic surgery identified RARP cases. Patients without a robotic-surgery procedure code were considered ORP cases in this subset of patients. Similar multivariable analyses were used to identify patient and hospital covariates associated with hospitalization cost. A two-sided p value ≤ 0.05 was used to determine statistical significance. Stata MP v.11.0 (StataCorp, College Station, TX, USA) was used to perform all statistical analyses.

3. Results

From the NIS and AHA merged data, we identified 29 837 patients who underwent RP for PCa at 605 hospitals from 2006 to 2008. The mean age was 60.94 yr (standard deviation: ±7.13). In comparison to ORP, patients undergoing RARP were, in general, more likely to be younger, white, and healthier, with a lower Elixhauser comorbidity index (Table 1). Furthermore, receipt of RARP was more likely among patients who were primarily insured with private health insurance (79.8% vs 74.8%; $p < 0.001$), resided in the highest-median-income area (41.8% vs 31.6%; $p < 0.001$), or treated at hospitals performing a high volume of RPs. Overall, median LOS and total hospitalization costs in our analytic cohort were 2 d (interquartile range [IQR]: 1–3 d) and $9933