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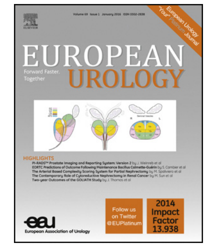

European Association of Urology

Prostate Cancer

Robot-assisted Versus Open Radical Prostatectomy: A Contemporary Analysis of an All-payer Discharge Database

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Abstract

Background: More than a decade since its inception, the benefits and cost efficiency of robot-assisted radical prostatectomy (RARP) continue to elicit controversy.
Objective: To compare outcomes and costs between RARP and open RP (ORP).
Design, setting, and participants: A cohort study of 629 593 men who underwent RP for localized prostate cancer at 449 hospitals in the USA from 2003 to 2013, using the Premier Hospital Database.
Intervention: RARP was ascertained through a review of the hospital charge description master for robotic supplies.
Outcome measures and statistical analysis: Outcomes were 90-d postoperative complications (Clavien), blood product transfusions, operating room time (ORT), length of stay (LOS), and direct hospital costs. Propensity-weighted regression analyses accounting for clustering by hospitals and survey weighting ensured nationally representative estimates.
Results and limitations: RARP utilization rapidly increased from 1.8% in 2003 to 85% in 2013 ($p < 0.001$). RARP patients ($n = 311\ 135$) were less likely to experience any complications (odds ratio [OR] 0.68, $p < 0.001$) or prolonged LOS (OR 0.28, $p < 0.001$), or to receive blood products (OR 0.33, $p = 0.002$) compared to ORP patients ($n = 318\ 458$). The adjusted mean ORT was 131 min longer for RARP ($p = 0.002$). The 90-d direct hospital costs were higher for RARP (+$4528, $p < 0.001$), primarily attributed to operating room and supplies costs. Costs were no longer signficantly different between ORP and RARP among the highest-volume surgeons ($\geq$104 cases/yr; +$1990, $p = 0.40$) and highest-volume hospitals ($\geq$318 cases/yr; +$1225, $p = 0.39$). Limitations include the lack of oncologic characteristics and the retrospective nature of the study.
Conclusions: Our contemporary analysis reveals that RARP confers a perioperative morbidity advantage at higher cost. In the absence of large randomized trials because of the widespread adoption of RARP, this retrospective study represents the best available evidence for the morbidity and cost profile of RARP versus ORP.
Patient summary: In this large study of men with prostate cancer who underwent either open or robotic radical prostatectomy, we found that robotic surgery has a better morbidity profile but costs more.

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1. Introduction

Prostate cancer is the commonest non–skin malignancy and the second leading cause of cancer death among men in the USA [1]. Radical prostatectomy (RP) is an established treatment modality for localized prostate cancer [2] and is associated with a survival advantage compared to watchful waiting [3]. In the past decade, robot-assisted RP (RARP) has rapidly increased in the USA, largely driven by extensive patient-directed marketing and interhospital competition to offer the latest technology. Despite the rapid adoption of RARP, there is no large-scale randomized controlled trial demonstrating its superiority over open RP (ORP) [4,5]. Instead, the best evidence so far has come from observational cohort studies and meta-analyses [6,7]. The latest comparative study of 5915 Medicare patients treated with either ORP or RARP between 2008 and 2009 found no differences in complications, readmissions, and additional cancer therapies, but a benefit with regard to blood transfusions and length of stay (LOS) [8]. Another National Inpatient Sample (NIS) study across the same time period and including 19 462 patients of all age groups and insurance status found lower rates of intraoperative and postoperative complications for RARP compared to ORP [9].

In light of these inconclusive findings regarding RP morbidity profiles, we sought to re-examine the perioperative outcomes and costs of RARP compared to ORP, hypothesizing that RARP would be associated with better morbidity but higher costs.

2. Patients and methods

2.1. Data source

We analyzed data from the Premier Hospital Database (Premier Inc., Charlotte, NC, USA), a nationally representative all-payer database capturing more than 45 million hospital inpatient discharges, representing approximately 20% of all hospitalizations in the USA. The Premier data have been validated and used in previous landmark studies [10,11]. We received institutional review board exemption for this study.

Hospital-specific projection weights are applied to each discharge to project the sample to a national estimate of inpatient discharges. The Premier projection methodology was validated by the Food and Drug Administration in 2001; it is based on a stratified comparison of the Premier inpatient database to all US hospitals responding to the American Hospital Association Annual Survey and validated through a comparison to projections using the National Hospital Discharge Survey. Hospital-level projection weights are then applied to each discharge in the Premier database. All numbers reported here refer to projected estimates.

2.2. Study cohort and main exposure

Using International Classification of Diseases, Ninth Revision (ICD-9) codes, we identified men diagnosed with prostate cancer (code 185) who underwent RP (code 60.5) between 2003 and 2013. Men with metastatic disease (196.x, 197.x, 198.x) and other malignancies (140.x to 209.79) were excluded. Patients who had a code for a robot-assisted procedure (ICD-9 code 17.42 or 17.44, introduced in October 2008) or a recorded charge code for robotic instrumentation were classified as RARP. These charge codes were obtained via a thorough review of the charge description master (CDM) to specifically identify supplies unique to robotic procedures by flagging every item in the EndoWrist Instrument and Assessory Catalog from Intuitive Surgical and performing a manual review, similar to the methodology as previously described [11,12]. We excluded the limited proportion of nonrobotic laparoscopic RPs (n = 27 619; 4.2%) to facilitate comparison between ORP and RARP only.

2.3. Covariates

We examined relevant patient, hospital, and surgical characteristics. Patient characteristics included age (yr), race (white, black, Hispanic, other/unknown), marital status (married, not married), insurance status (Medicare, Medicaid, private, other/unknown), and Charlson comorbidity index (0, 1, $\geq$2). Hospital characteristics included teaching status, hospital size ($<$400, 400–600, or $>$600 beds), location (urban or rural), and geographic region (Midwest, Northeast, South or West). Surgical characteristics included year of procedure, type of surgical approach (robotic vs open), and annual surgeon and hospital volume. Annual surgical volume was calculated using the annual number of RPs performed, irrespective of surgical approach. In the absence of clear cutoff references [13], we defined the highest volume as $\geq$75th percentile (highest quartile), as other authors have done [14–16]. This yielded cutoffs of $\geq$104 cases/yr ($\geq$2 cases/wk) for surgeon volume and$\geq$318 cases/yr (nearly 1 case/d) for hospital volume.

2.4. Endpoints

We used ICD-9 codes to identify events defined by the Clavien classification system, including events not present at the time of admission for RP but occurring during the index hospital stay and/or on re-admission to the hospital within 90 d of the procedure [17]. Patients with events managed in the outpatient setting were not captured. Complications were classified as any (Clavien grade 1–5) or major (Clavien grade 3–5). Clavien grade 5 denoted mortality and was identified through disposition codes. Our methodology met seven of the ten Martin criteria according to European Association of Urology guidelines [18].

We used the CDM to determine the number of units of blood product utilized and operating room time (ORT). ORT indicates actual ORT instead of time from incision to closure, allowing inference about operating room (resource) utilization ("wheels in, wheels out") rather than the speed of the surgeon (eg, robotic console time). Hospital LOS (in days) was directly captured by the database, indicating the period from admission to discharge. Prolonged LOS was defined as stays longer than the median LOS of 2 d.

Total expenditure associated with surgery was estimated using 90-d direct hospital costs for each patient. This consisted of the actual cost for treating the patient, including supplies, labor, and depreciation of equipment, and comprised variable (direct) and fixed (overhead) costs. The capital costs and annual maintenance fees associated with the robotic platform were not included; these fixed costs per case depend on the specific type of robotic unit as well as amortization of these costs according to the frequency and duration of use [19,20], none of which is reliably available in the current database. To facilitate comparison, all costs were adjusted to 2014 US dollars using the consumer price index.

2.5. Statistical analyses

Using descriptive statistics, we compared baseline characteristics between ORP and RARP using χ^2 (categorical) and Mann-Whitney (continuous) tests. For continuous outcomes (LOS, ORT, and 90-d direct hospital costs), differences between ORP and RARP exhibited a gamma distribution, so we constructed generalized linear regression models.

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