Centralization of Radical Prostatectomy in the United States

Christopher B. Anderson,* David F. Penson, Shenghua Ni, Danil V. Makarov and Daniel A. Barocas†

From the Department of Urologic Surgery (CBA, DFP, SN, DAB), and Center for Surgical Quality and Outcomes Research (DFP, DAB), Vanderbilt University Medical Center, and United States Department of Veterans Affairs Tennessee Valley Geriatric Research, Education, and Clinical Center (DFP), Nashville, Tennessee, and Department of Urology, New York University School of Medicine and the United States Department of Veterans Affairs New York Harbor Healthcare System, New York, New York (DVM)

Abbreviations and Acronyms

RALP = robotic assisted laparoscopic prostatectomy

RP = radical prostatectomy

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* Correspondence: Department of Urologic Surgery, Vanderbilt University Medical Center, A-1302 Medical Center North, Nashville, Tennessee 37232-2765 (telephone: 615-322-2101; FAX: 615-322-8990; e-mail: c.anderson@vanderbilt.edu).

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Purpose: Radical prostatectomy is a common treatment for organ confined prostate cancer and its use is increasing. We examined how the increased volume is being distributed and what hospital characteristics are associated with increasing volume.

Materials and Methods: We identified all men age 40 to less than 80 years who underwent radical prostatectomy for prostate cancer from 2000 to 2008 in the NIS (Nationwide Inpatient Sample) (586,429). Ownership of a surgical robot was determined using the 2007 AHA (American Hospital Association) Annual Survey. The association between hospital radical prostatectomy volume and hospital characteristics, including ownership of a robot, was explored using multivariate linear regression.

Results: From 2000 to 2008 there was a 74% increase in the number of radical prostatectomies performed ($p = 0.05$) along with a 19% decrease in the number of hospitals performing radical prostatectomy ($p < 0.001$), resulting in an increase in annual hospital radical prostatectomy volume ($p = 0.009$). Several hospital variables were associated with greater radical prostatectomy volume including teaching status, urban location, large bed size and ownership of a robot in 2007. On multivariate analysis the year, teaching status, large bed size, urban location and presence of a robot were associated with higher hospital radical prostatectomy volume.

Conclusions: Use of radical prostatectomy increased significantly between 2000 and 2008, most notably after 2005. The increase in radical prostatectomy resulted in centralization to select hospitals, particularly those in the top radical prostatectomy volume quartile and those investing in robotic technology. Our findings support the hypothesis that hospitals with the greatest volume increases are specialty centers already performing a high volume of radical prostatectomy procedures.

Key Words: prostatectomy, prostatic neoplasms, trends, robotics

Prostate cancer is the most frequently diagnosed malignancy among men and the second leading cause of male cancer mortality in the United States.[1] Radical prostatectomy is the most commonly used treatment for clinically localized prostate cancer, especially among healthy men.[2] Recent studies at the state[3,4] and national[5] level have demonstrated an increase in RP use, raising questions about how the volume is being distributed. As opposed to a proportional volume increase among all hospitals, RP appears be increasing in a pattern consistent with centralization to certain institutions.[3,4,6]

While centralization is potentially desirable for certain operations given its association with improved surgical

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quality, some fear it may lead to decreased access to care, increased travel distances and diminished business at low volume hospitals.[7–9] There are many proposed explanations for centralization, including referral patterns and hospital business strategy.[10–12] However, nationwide RP centralization in the absence of a policy mandate could have unintended consequences for quality or access to care if driven by market forces alone.

Robotic assisted laparoscopic prostatectomy has rapidly grown to account for more than two-thirds of RP nationwide.[13,14] Recent studies suggest that RP is becoming centralized to hospitals that own robots and some believe the popularity of RALP is related to increasing RP volume.[3–5,13,15] Whether hospital volume and robot ownership are associated at the national level is not known. In this study we determined whether centralization of RP is occurring nationally and which hospital characteristics are associated with higher RP volume, with particular attention to robot ownership.

MATERIALS AND METHODS

The NIS is a large administrative database with information on patient demographics, diagnosis and procedure codes, and several hospital characteristics for each inpatient discharge. The NIS represents a 20% stratified sample from more than 1,000 United States community hospitals in 42 states and is intended to reflect nationwide trends.

We included all men in the NIS age 40 to less than 80 years who underwent RP between 2000 and 2008 for prostate cancer. Patients were identified by ICD procedure code (60.5 for RP) and diagnosis code (185 or 198.82 for prostate cancer). Patients were excluded from study if they underwent RP concurrently with radical cystectomy for bladder cancer.

The NIS does not have data on hospital ownership of a robot and cannot be used to determine if RP was performed robotically until the final quarter of 2008. Therefore, we merged the NIS with the 2007 AHA Annual Survey based on AHA hospital identification number, which is present in approximately 60% of NIS discharges. The AHA survey records data on whether a hospital owned a robot in 2007, but not on the year the robot was purchased or how many robots a hospital owns. NIS hospitals without an AHA identifier were classified as having an unknown status for robotic ownership. To internally validate the AHA variable we identified all NIS hospitals that submitted a procedure code for robotic assistance (17.4x) in the final quarter of 2008, and reexamined the associations among robotic ownership, hospital characteristics and procedure volume. As the results were nearly identical to those using the AHA variable (data not shown), we were confident that the AHA variable was internally valid.

The main outcome was annual number of RPs performed per hospital. Hospital volume was estimated for all hospitals performing 1 or more RP. Hospitals with 1 or more NIS discharge but no RP discharge were labeled as having zero RP discharges that year. Hospitals with zero NIS discharges (indicating they were not sampled that year) were considered to have missing RP discharge data.

Descriptive hospital data were weighted per NIS protocol and presented as averages during 3-year periods, generally corresponding to the phases of robot diffusion (2000 to 2002—introduction, 2003 to 2005—early adoption, 2006 to 2008—widespread diffusion). Hospitals were stratified by volume quartile each year of analysis, and associations between RP volume and hospital characteristics were measured using ANOVA and chi-square tests for continuous and categorical variables, respectively. Linear regression models were used to examine bivariate associations of overall RP volume, number of hospitals performing RP, average annual hospital RP volume and proportion of cases performed at various types of hospitals over time.

A mixed effects multivariate linear regression model was used to examine the relationship among hospital characteristics, time and hospital RP volume. We included a random effect for state to account for the possibility that the association between hospital characteristics and RP volume might vary by region. We performed a sensitivity analysis using 2 additional multivariate models to account for hospitals with unknown robotic ownership status. We performed a separate multivariate analysis stratified by time period to determine whether the relationship between hospital characteristics and outcome was consistent over time. Correlation coefficients were calculated between each hospital variable, and any variable that was highly correlated with another ($r > 0.9$) was excluded from the multivariate analysis to maintain the assumption of noncollinearity. However, no variables met this criterion (max $r = 0.49$) and all were included in the models. All statistical analysis was performed using SAS® statistical software (version 9.2) and all p values ≤ 0.05 were considered statistically significant.

RESULTS

A total of 586,429 patients underwent RP from 2000 to 2008. Hospital volume thresholds ranged from 3 to 5 for the 25th percentile, 10 to 13 for the 50th percentile and 24 to 43 for the 75th percentile, depending on the year of analysis. The majority of patients were white, privately insured and healthy. There were significant differences in the types of patients treated across hospital volume quartiles (supplementary tables 1 and 2, www.jurology.com). The majority of hospitals performing RP were nonteaching, private not-for-profit, in an urban setting and with a medium or large bed size (see table). Compared to hospitals in the lowest volume quartile, those hospitals in the highest volume quartile tended to be teaching hospitals (67.9% vs 18.6%, $p = 0.059$), to be located in an urban setting (96.1% vs 73.7%, $p < 0.001$), to have a large bed size (72.4% vs 41.2%, $p < 0.001$), to be private not-for-profit