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THE IMPACT OF HOSPITAL VOLUME, RESIDENCY AND FELLOWSHIP TRAINING ON PERIOPERATIVE OUTCOMES AFTER RADICAL PROSTATECTOMY

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SUMMARY

Objectives—Although high-volume hospitals have been associated with improved outcomes for radical prostatectomy (RP), the association of residency and/or fellowship teaching institutions and this volume-outcome relationship remains poorly described. We examine the effect of teaching status and hospital volume (HV) on perioperative RP outcomes.

Methods and Materials—Within the Nationwide Inpatient Sample (NIS), we focused on RPs performed between 2003 and 2007. We tested the rates of prolonged length of stay (pLOS) beyond the median of 3 days, in-hospital mortality, as well as intraoperative and postoperative complications, stratified according to teaching status. Multivariable logistic regression analyses further adjusted for confounding factors.

Results—Overall, 47,100 eligible RPs were identified. Of these, 19,193 cases were performed at non-teaching institutions, 24,006 at residency teaching institutions and 3901 at fellowship teaching

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institutions. Relative to patients treated at non-teaching institutions, patients treated at fellowship teaching institutions were healthier and more likely to hold private insurance. In multivariable analyses, patients treated at residency (OR=0.92, p=0.015) and fellowship (OR=0.82, p=0.011) teaching institutions were less likely to experience a postoperative complication than patients treated at non-teaching institutions. Patients treated at residency (OR=0.73, p<0.001) and fellowship (OR=0.91, p=0.045) teaching institutions were less likely to experience a pLOS.

Conclusions—More favorable postoperative complication profile and shorter length of stay should be expected at residency and fellowship teaching institutions following RP. Moreover, postoperative complication rates were lower at fellowship teaching than at residency teaching institutions, despite adjustment for potential confounders.

Keywords

Prostatic Neoplasms; Prostatectomy; Complication; Teaching; Residency; Fellowship

INTRODUCTION

Radical prostatectomy (RP) represents one of the principal management options for patients with clinically localized prostate cancer[1]. Several patient and system attributes associated with favorable outcomes after RP have been identified, namely patient age, baseline comorbidity profile, geographical region[2], as well as surgeon and hospital volume (HV) [3]. Moreover, institutional teaching status might also represent an important predictor of perioperative outcomes[4–7]. Investigators have postulated that the sub-specialty practice profile at tertiary teaching institutions may be associated with improved outcomes. Conversely, the increased complexity of cases performed at tertiary teaching centers may also undermine outcomes.

Currently, many urologists are pursuing advanced training in urology. Professional organizations, such as the Society of Urologic Oncology (SUO) and the Endourological Society have developed accreditation guidelines to define adequate fellowship training. However, there are limited data supporting the competence of these initiatives. Given the lack of available data, we sought to explore the effect of HV, residency and fellowship accreditation status on four immediate and short-term RP outcomes. Specifically, we focus on intraoperative and postoperative complications, prolonged length of stay (pLOS) beyond the median of three days, and on in-hospital mortality.

METHODS

Data Source

Data from five contemporary years (2003–2007) of the Nationwide Inpatient Sample (NIS) were abstracted. The NIS includes inpatient discharge data collected via federal-state partnerships, as part of the Agency for Healthcare Research and Quality’s Healthcare Cost and Utilization Project.

Sample population and surgical procedures

Relying on discharge records, all patients with a primary diagnosis of prostate cancer (ICD-9-CM code 185) were considered for the study. The prostatectomy procedure code (ICD-9-CM 60.5) resulted in the identification of 63,827 patients.

Baseline patient and hospital characteristics

For all patients, the following variables were available: age, year of surgery, ethnicity (white vs. black vs. other vs. unknown), Charlson Comorbidity Index (CCI), HV, accreditation status, hospital region and insurance status. Information about hospital region was obtained from the American Hospital Association Annual Survey of Hospitals, and defined by the United States Census Bureau[8]. CCI, based on the comorbidity scale developed by Charlson et al[9] and adapted by Deyo et al[10], was derived from ICD-9 codes according to previously established criteria[11] and was stratified according to four levels: 0, 1, 2 and ≥3. HV was defined according to the number of procedures performed at each participating institution, and was calculated for each study calendar year.

Institutional teaching status was obtained from the AHA Annual Survey of Hospitals. A hospital is considered to be a teaching hospital if it has an American Medical Association-approved residency program, is a member of the Council of Teaching Hospitals or has a ratio of full-time equivalent interns and residents to beds of 0.25 or higher. Detailed information on accredited urologic oncology fellowship training was obtained from the website of the Society of Urologic Oncology[12]. The NIS hospital universe was then searched for all hospitals related to the institutions listed in the aforementioned website. NIS hospital identification numbers were determined for all hospitals included in both groups, and appropriate notation was added to the discharge level entry in the NIS dataset. Of the 32 accredited fellowship programs, 12 were excluded from subsequent analyses: two fellowship programs were not located in the USA, eight were based in states in which hospital identification was not provided and two were not found within the NIS hospital universe. Since all accredited fellowship institutions were also teaching institutions, we were able to stratify teaching status into three categories: non-teaching, teaching without accredited fellowship program (residency teaching) and teaching with accredited fellowship program (fellowship teaching). To minimize confounding, patients from states in which hospital identification was not provided were excluded, resulting in 47,100 eligible cases for subsequent analyses. While sampling weights are typically incorporated into NIS population-based studies, we elected not to perform weighted analyses in the current study due to the large number of excluded patients.

Intraoperative and postoperative complications during hospitalization

The presence of any complication was defined using ICD-9 diagnoses 2 through 15, as previously described [13, 14]. Intraoperative complications consisted of surgical laceration of the bowel, ureter and nerves and/or vessels. For statistical analysis purposes, we stratified patients by 0 vs. 1 or greater complications during hospitalization.

Length of stay and in-hospital mortality

Length of stay, provided by the NIS, is calculated by subtracting the admission date from the discharge date. In-hospital mortality information is coded from disposition of the patient.

Statistical analysis

Descriptive statistics focused on frequencies and proportions for categorical variables. Means, medians and ranges were reported for continuously coded variables. The chi-square and analysis of variance tests were used to compare the statistical significance of differences in proportions and means, respectively.

Subsequently, we focused on the rates of intraoperative complications, postoperative complications, pLOS, and in-hospital mortality. We then relied on multivariable logistic regression models to quantify the effect of institutional teaching status on these outcomes. Regression analysis did not take into account clustering of patients within hospitals, because choice of hospital was the independent variable being tested. We performed several additional analyses to better assess the associations between teaching practice profiles and in-hospital outcomes after RP. Specifically, analyses were repeated for each hospital volume category, as to reduce the confounding effect of caseload distributions. Similarly, sensitivity analyses were performed, by limiting the cohort to only those aged 60 years and older, those without any baseline comorbidities, as well as those treated with the open approach. All tests were two-sided, with a statistical significance set at p<0.05. Analyses were conducted using the R statistical package (the R foundation for Statistical Computing, version 2.15.0).

RESULTS

Between 2003 and 2007, 47,100 eligible radical prostatectomies were recorded within the National Inpatient Sample. Of these, 19,193 (40.7%) cases were performed at non-teaching institutions, 24,006 (51.0%) at residency teaching institutions and 3901 (8.3%) at fellowship teaching institutions. Baseline characteristics of patients undergoing RP in the NIS between 2003 and 2007 are listed in Table 1. Median HV was 33, 100 and 318 cases per year at non-teaching, residency teaching and fellowship teaching institutions, respectively (p<0.001). Relative to patients treated at non-teaching institutions, patients treated at fellowship teaching institutions had fewer comorbidities (CCI of 0 in 84.8 vs. 78.2%) and were more likely to hold private insurance (66.5 vs. 61.9%, all p<0.001).

Intraoperative and postoperative outcomes that were recorded during hospital stay and stratified according to institutional teaching status are shown in Table 2. Relative to patients treated at non-teaching institutions, patients treated at residency and fellowship teaching institutions were less likely to experience postoperative complications (12.2 vs. 10.2 and 7.3%, p<0.001). Specifically, the rates of cardiac (1.4 vs. 1.0 and 0.9%, p=0.001), respiratory (2.4 vs. 1.8 and 0.9%, p<0.001) and miscellaneous medical (6.1 vs. 5.1 and 3.4%, p<0.001) complications were lower in patients treated at residency and fellowship teaching institutions. Patients treated at residency and fellowship teaching institutions were also less likely to experience a pLOS (23.9 vs. 15.3 and 8.6%, p<0.001). There was no significant difference between groups when intraoperative complications (p=0.127) and in-hospital mortality (p=0.413) rates were compared.

In-hospital morbidity and mortality rates were also examined according to months throughout the years, and stratified according to residency/fellowship teaching and non-teaching hospitals. With respect to all examined endpoints, only for pLOS was there a significant decrease overtime amongst patients treated at residency teaching hospitals (from 27.0 to 20.4%, P=0.02) and non-teaching hospitals (from 17.6 to 13.8%, P=0.03, data not shown).

In multivariable analyses adjusted for institutional teaching status, age, race, year of surgery, CCI, hospital region and location, surgical approach and insurance status, HV was an independent predictor of the likelihood to experience an intraoperative (p=0.004) or postoperative ($p<0.001$) complication, as well as to experience a pLOS ($p<0.001$), as demonstrated by improved outcomes per additional procedure performed per institution (Table 3). An incremental change in in-hospital mortality was not demonstrated as HV increased.

In multivariable analyses adjusted for HV, age, race, year of surgery, CCI, hospital region and location, surgical approach and insurance status, institutional teaching status was an independent predictor of the likelihood to experience an intraoperative or postoperative complication, as well as to experience a pLOS (Table 4). Specifically, patients treated at residency teaching institutions were more likely to experience an intraoperative complication (OR=1.21, p=0.035). Moreover, patients treated at residency (OR=0.92, p=0.015) and fellowship (OR=0.82, p=0.011) teaching institutions were less likely to experience a postoperative complication. Finally, patients treated at residency (OR=0.73, $p<0.001$) and fellowship (OR=0.91, p=0.045) teaching institutions were less likely to be experience a pLOS.

Since hospital volume distribution differed substantially between non-teaching and residency/fellowship teaching hospitals, we performed sub-analyses according to hospital volume groups: low (1–33), intermediate (34–93), and high (>93). Two observations are noteworthy (Table 5). First, the increased rate of intraoperative complications at residency/fellowship teaching hospitals within the entire population predominantly originated from those treated at low/intermediate-volume hospitals. Second, with respect to postoperative complications, fellowship accreditation remained associated with more optimal outcomes compared to non-teaching hospitals. However, this effect was not recorded amongst patients treated at low-volume hospitals.

In additional analyses, our findings showed that the protective effect of training programs was less apparent in patients aged greater than 60 years old, reflecting the importance of selection of surgical candidates, regardless of hospital characteristics and expertise (Table 6). Moreover, amongst patients with no baseline comorbidity at RP, residency/fellowship teaching hospital-treated individuals remained less likely to experience a postoperative complication than their non-teaching counterparts. However, the significant effect of fellowship teaching hospital on pLOS dissipated. Finally, when analyses were restricted to those only treated with the open approach, the protective effect of residency/fellowship teaching hospitals with respect to postoperative complications and pLOS remained applicable.

DISCUSSION

Assuming no change in the actuarial incidence rates of prostate cancer, more men will be diagnosed with prostate cancer in the next decades. Application of current incidence rates to future age-specific population distribution projections estimates the annual incidence of prostate cancer at 452,000 new cases in the year 2045[15]. Of those, a significant portion will undergo RP. In this context, it is essential to evaluate and to optimize the outcomes of patients undergoing RP.

Our analyses showed that HV was significantly associated with several endpoints within our study, independent of other patient and hospital characteristics. Specifically, in adjusted analyses, an increment in HV was inversely associated with the likelihood of intraoperative and postoperative complications, as well as the likelihood of pLOS.

The relationship between HV and postoperative outcomes has been confirmed in several procedures, including RP[16–18]. These findings have led to the concept of regionalization of care to high HV centers[19], based on the practice-makes-perfect hypothesis, in which a higher caseload results in yet greater experience. Such regionalization is supported by health initiatives such as the Leapfrog Group for Patient Safety[20]. While our analyses recapitulate and further substantiate the findings of previous reports, there is no established causal relationship between HV and outcomes.

Even after controlling for HV, residency or fellowship teaching status remained independent predictors of lower postoperative complications rates and shorter length of stay. This finding indicates that the effect of residency or fellowship teaching status is independent of HV. Moreover, postoperative complication rates were better at fellowship teaching institutions than at residency teaching institutions. Previous studies corroborate that performance of RP at an academic institution, even when controlled for HV, is associated with improved complication rates and LOS [7].

That said, patients treated at residency and fellowship teaching institutions were predominantly identified amongst high HV centers. Since better outcomes associated with teaching status may be due to the recurring effect of HV, we performed sensitivity analyses to examine the impact of teaching practice profiles according to hospitals with comparable HV distributions. In this regard, our results support the concomitant relationship of teaching practice profiles and HV. Specifically, if treatment is considered in the low HV setting, then postoperative outcomes after RP will not be that different across residency/fellowship teaching and non-teaching hospitals. In fact, our results showed that some intraoperative outcomes may be even higher. However, if treatment is considered in the high HV setting, then teaching practice profiles matter.

The impact of residency vs. fellowship accreditation has previously been addressed. In a population-based analysis between the years 1998 to 2006, Kohn et al. reported on the effect of residency and fellowship training on bariatric surgery outcomes[21]. Hospitals with a Fellowship Council-affiliated program were associated with lower rates of splenectomy and bacterial pneumonia. Similarly, residency training was associated with lower rates of pulmonary embolism, bacterial pneumonia, respiratory failure and cardiac complications. Interestingly, Center-of-Excellence (COE) status, irrespective of the accrediting entity, had minimal effect on outcomes. In another study, Kohn et al. showed that hospitals supporting a surgical residency program had lower overall morbidity and mortality[22]. Conversely, a fellowship program was not associated with overall lower morbidity and mortality and appeared to result in a higher rate of "other" complications.

To our knowledge, the current analysis represents the first study to suggest that better postoperative outcomes may be expected at fellowship training than residency training institutions. While speculative, it is possible that completion of residency, as well as self-selection for and acceptance to fellowship, provides for improved intraoperative and postoperative experience in patient care, and a higher degree of acumen is required to teach fellowship-level than resident-level competency. Further, although the volume-outcome relationship has been well documented for many complex surgeries, including RP, and has been advocated for as one possible mechanism for improving the quality of care by centralization of surgical care, the specific structural or process of care features responsible for better outcomes have yet to be fully defined. While our study demonstrates that training institutions with residency and/or fellowship programs indeed had better outcomes, it is likely that presence of advanced training programs served as proxy measures for key hospital characteristics responsible for the lower complication profile and LOS.

Nonetheless, these results need to be interpreted with some caution. Specifically, fellowship teaching institutions were limited to centers with SUO-accredited fellowship. In consequence, several COE with fellowship programs were not included in the current analysis, which may have induced a bias. It is likely that most of these institutions perform RP equally well. On the other hand, some of the fellowship teaching institutions included in the study may be specialized in procedures other than that of RP. In addition, SUO credentialing status has changed over the years. Some centers included in this study were not credentialed in the years selected for this study. Nonetheless, it is likely that similar support and surgical experience before and after the credentialing period were present. Restricting our analyses to the most contemporary years further minimizes the effect of this potential confounder. Moreover, unlike bariatric surgery, there is no publicly available registry of COE[23]. Ideally, a comparative analysis focusing on such centers should be performed. Finally, a patient undergoing RP at a listed fellowship teaching institution may not have been operated on by the academic surgeon for which the accreditation status was given and/or the fellow. These limitations within our analyses necessitate caution in the interpretation of our results. Nonetheless, its novelty merits future considerations and validations.

Several other variables, such as patient (disease characteristics, BMI, medication) and socio-economical determinants (which may impact access to care), as well as surgeon characteristics may be advanced to explain the recorded differences. Unfortunately, these variables were not available in the database. For example, patients with more aggressive disease may be diverted towards certain types of institution. However, evidence suggests that morbidity and mortality after RP for locally advanced vs. localized disease are similar [24]. Second, there is evidence suggesting that variability in postoperative morbidity vary greatly according to surgical performance, despite adjustment for HV and case mix scenarios. The lack thereof may have confounded our results. That said, many previous landmark publications were also limited by this factor. [25, 26] Third, administrative records may underestimate complication rates. Moreover, it is possible that administrative records are better maintained at teaching hospitals due to a higher number of personnel involved in the recording and verification of the data input. It may be possible that the more stringent reporting of comorbidities at teaching institutions could have elicited better outcomes. In that regard, our subgroup analyses revealed that after limiting the cohort to those without any baseline comorbidity at RP, the protective effect of fellowship hospital with respect to pLOS disappeared, suggesting that patient selection may be partly responsible for the extended hospitalization time between non-teaching hospital and fellowship teaching hospital. Additionally, our results predominantly reflect postoperative morbidity after RP in the open setting, where only 5–16% of patients are treated with a minimally invasive approach. It may be possible that with increasing popularity of robotic-assisted RPs, after overcoming the initial learning curve, treatment at some non-teaching hospitals will result in comparable outcomes relative to residency/fellowship training programs. Finally, rates of postoperative readmission and re-intervention were beyond the scope of this study, which addressed more immediate outcome measures.

Our study may help better understand the volume outcome relationship for patients undergoing RP for prostate cancer. Although our findings may be construed as counterintuitive in that training institutions with presence of residency or SUO accredited fellowship are associated with lower rates of postoperative complications and LOS, one policy inference is that further investigation is needed to identify which specific structural and process of care features at teaching hospitals are responsible for improving outcomes for prostate cancer patients undergoing RP. Indeed, this type of research may help formulate more effective strategies in transferring this type of quality of care improvement across all hospitals in the U.S.

CONCLUSION

Our results indicate that on average, more favorable postoperative complication profile and shorter length of stay should be expected at residency and fellowship teaching institutions. Moreover, postoperative complication rates were better at fellowship teaching than at residency teaching institutions, despite adjustment for potential confounders. To the best of our knowledge, the current analysis represents the first study to suggest that better postoperative outcomes may be expected at fellowship training than residency training institutions. Finally, HV was an independent predictor of the likelihood to experience an intraoperative or postoperative complication, as well as to experience a pLOS.

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Table 1

Demographic characteristics of patients treated with radical prostatectomy for prostate cancer, stratified according to institutional teaching status, Nationwide Inpatien Sample, 2003 – 2007.

	Non-teaching	Residency teaching	Fellowship teaching	*P*
No. of patients	19193	24006	3901	–
No. of hospitals	726	337	20	–
Mean age (median)	61.6 (62.0)	60.5 (61.0)	59.5 (61.0)	**<0.001**
Range	35–89	28–88	28–88	
Mean hospital volume (median)	57.6 (33.0)	121.0 (100.0)	363.0 (318)	**<0.001**
Range	1–323	1–421	4–780	
Race				**<0.001**
White	10973 (57.2)	14014 (58.4)	1842 (47.2)	
Black	1134 (5.9)	2259 (9.4)	249 (6.4)	
Other*	1360 (7.1)	1995 (8.3)	368 (9.4)	
Unknown	5726 (29.8)	5738 (23.9)	1442 (37.0)	
Year of surgery				**<0.001**
2003	3821 (19.9)	4644 (19.3)	562 (14.4)	
2004	3696 (19.3)	4411 (18.4)	143 (3.7)	
2005	3536 (18.4)	3544 (14.8)	877 (22.5)	
2006	3645 (19.0)	5435 (22.6)	701 (18.0)	
2007	4495 (23.4)	5972 (24.9)	1618 (41.5)	
CCI†				**<0.001**
0	15003 (78.2)	19421 (80.9)	3307 (84.8)	
1	3605 (18.8)	4028 (16.8)	511 (13.1)	
2	451 (2.3)	417 (1.7)	57 (1.5)	
≥3	134 (0.7)	140 (0.6)	26 (0.7)	
Hospital region‡				**<0.001**
Northeast	2795 (14.6)	7494 (31.2)	1135 (29.1)	
Midwest	3149 (16.4)	5281 (22.0)	582 (14.9)	
South	5520 (28.8)	5456 (22.7)	1027 (26.3)	
West	7729 (40.3)	5775 (24.1)	1157 (29.7)	
Hospital location				**<0.001**
Rural	2340 (12.2)	500 (2.1)	0 (0.0)	
Urban	16853 (87.8)	23506 (97.9)	3901 (100.0)	
Insurance status				**<0.001**
Private	11873 (61.9)	16235 (68.2)	2594 (66.5)	
Medicaid	267 (1.4)	444 (1.8)	222 (5.7)	
Medicare	6324 (32.9)	6269 (26.1)	795 (20.4)	

	Non-teaching	Residency teaching	Fellowship teaching	*P*
Other	729 (3.8)	928 (3.9)	290 (7.4)	
Surgical approach				
Open	18295 (95.3)	21940 (91.4)	3261 (83.6)	**<0.001**
Minimally invasive	898 (4.7)	2066 (8.6)	640 (16.4)	

Abbreviation: CCI: Charlson Comorbidity Status

*Includes Asian, Pacific Islander, Native American, other unspecified

†Based on Comorbidity developed by Charlson et al. and adapted by Deyo et al.

‡Hospital region is defined by the US Census Bureau.

Table 2

Intraoperative and postoperative outcomes during hospitalization stratified according to institutional teaching status.

	Non-teaching	Residency teaching	Fellowship teaching	*P*
No. of patients	19193	24006	3901	—
Intraoperative complication	262 (1.4)	337 (1.4)	39 (1.0)	**0.12**
Postoperative complication				
Overall	2337 (12.2)	2444 (10.2)	283 (7.3)	**<0.0**
Cardiac	266 (1.4)	247 (1.0)	37 (0.9)	**0.00**
Respiratory	458 (2.4)	437 (1.8)	37 (0.9)	**<0.0**
Vascular	104 (0.5)	98 (0.4)	15 (0.4)	**0.09**
Operative wound	71 (0.4)	114 (0.5)	15 (0.4)	**0.23**
Genitourinary	185 (1.0)	285 (1.2)	36 (0.9)	**0.05**
Miscellaneous medical	1177 (6.1)	1232 (5.1)	131 (3.4)	**<0.0**
Miscellaneous surgical	553 (2.9)	618 (2.6)	92 (2.4)	**0.06**
Length of stay, days				
Length of stay >3 days	4592 (23.9)	3676 (15.3)	337 (8.6)	**<0.0**
In-hospital mortality	17 (0.1)	14 (0.1)	4 (0.1)	**0.41**

Table 3

The incremental effect of each additional case of radical prostatectomy performed annually on perioperative outcomes, adjusted for age, year of surgery, race, CCI, hospital region and location, surgical approach and insurance status

	OR (95% CI)	P
Intraoperative complication	0.9987 (0.9977–0.9996)	0.004
Postoperative complication		
Overall	0.9990 (0.9987–0.9993)	<0.001
Cardiac	0.9995 (0.9986–1.0004)	0.264
Respiratory	0.9983 (0.9975–0.9992)	<0.001
Vascular	0.9985 (0.9969–1.0001)	0.006
Operative wound	0.9994 (0.9980–1.0008)	0.410
Genitourinary	1.0004 (0.9995–1.0012)	0.424
Miscellaneous medical	0.9988 (0.9984–0.9993)	<0.001
Miscellaneous surgical	0.9990 (0.9984–0.9996)	0.002
Length of stay, days		
Length of stay >3 days	0.9948 (0.9944–0.9952)	<0.001
In-hospital mortality	0.9964 (0.9925–1.0003)	0.07

Abbreviation: CCI: Charlson Comorbidity Status OR: Odds ratio

Table 4

Multivariable analyses adjusted for age, year of surgery, race, CCI, hospital region and location, surgical approach, insurance status, and hospital volume

	Residency teaching vs. non-teaching		**Fellowship teaching vs. non-teaching**	
	OR after inclusion of hospital volume	**P**	**OR after inclusion of hospital volume**	**P**
Intraoperative complication	1.21 (1.01–1.45)	0.035	1.09 (0.74–1.62)	0.654
Postoperative complication				
Overall	0.92 (0.86–0.98	0.015	0.82 (0.7–0.95)	0.011
Cardiac	0.78 (0.65–0.95)	0.012	0.93 (0.6–1.43)	0.729
Respiratory	0.9 (0.78–1.04)	0.156	0.67 (0.45–0.98)	0.037
Vascular	0.82 (0.61–1.11)	0.202	1.19 (0.62–2.29)	0.599
Operative wound	1.33 (0.96–1.84)	0.082	1.24 (0.62–2.5)	0.540
Genitourinary	1.26 (1.03–1.54)	0.025	0.9 (0.57–1.42)	0.655
Miscellaneous medical	0.91 (0.84–1)	0.053	0.76 (0.61–0.94)	0.012
Miscellaneous surgical	1.02 (0.9–1.16)	0.731	1.15 (0.88–1.5)	0.304
Length of stay, days				
Length of stay >3 days	0.73 (0.69–0.77)	<0.001	0.91 (0.83–0.99)	0.045
In-hospital mortality	0.73 (0.34–1.57)	0.421	3.31 (0.88–12.38)	0.076

Abbreviation: CCI: Charlson Comorbidity Status OR: Odds ratio

Table 5

Sensitivity analyses of teaching practice programs across hospital volume categories*

	Residency teaching vs. Non-teaching		Fellowship teaching vs. Non-teaching	
	OR (95% CI)	***P***	**OR (95% CI)**	***P***
Intraoperative complications				
Low HV	1.22 (0.88–1.68)	0.2	3.16 (1.35–7.37)	0.008
Intermediate HV	1.37 (1.02–1.85)	0.04	1.20 (0.52–2.78)	0.7
High HV	1.03 (0.72–1.48)	0.9	0.69 (0.42–1.13)	0.1
Postoperative complications				
Low HV	1.06 (0.94–1.19)	0.3	1.16 (0.71–1.87)	0.6
Intermediate HV	0.93 (0.83–1.04)	0.2	0.53 (0.34–0.80)	0.003
High HV	0.96 (0.83–1.10)	0.5	0.73 (0.61–0.88)	0.001
pLOS				
Low HV	0.99 (0.90–1.07)	0.7	0.54 (0.36–0.82)	0.004
Intermediate HV	0.98 (0.89–1.08)	0.7	0.67 (0.49–0.93)	0.02
High HV	0.79 (0.68–0.91)	0.002	0.73 (0.61–0.87)	0.001

*Models for prediction of in-hospital mortality were not performed due to insufficient number of events observed for each subgroup.

HV: hospital volume, OR: odds ratio, CI: confidence interval, pLOS: prolonged length of stay

All models adjusted for patient age, year of surgery, race, hospital region, hospital location, comorbidities, insurance status, and RP approach.

Table 6

Sensitivity analyses of teaching practice programs across age, comorbidities and radical prostatectomy approach*

	Residency teaching vs. Non-teaching		Fellowship teaching vs. Non-teaching	
	OR (95% CI)	***P***	**OR (95% CI)**	***P***
>60 years old only				
Intraoperative complications	1.19 (0.95–1.50)	0.2	1.35 (0.82–2.22)	0.2
Postoperative complications	0.94 (0.87–1.02)	0.1	0.74 (0.60–0.91)	0.004
pLOS	0.72 (0.67–0.77)	<0.001	0.92 (0.77–1.11)	0.4
In-hospital mortality	0.62 (0.26–1.5)	0.3	1.11 (0.17–7.33)	0.9
CCI 0 only				
Intraoperative complications	1.20 (0.98–1.47)	0.1	0.98 (0.63–1.54)	1.0
Postoperative complications	0.92 (0.86–0.99)	0.04	0.81 (0.68–0.96)	0.02
pLOS	0.74 (0.69–0.78)	<0.001	0.94 (0.81–1.10)	0.4
In-hospital mortality	0.53 (0.21–1.34)	0.2	3.18 (0.78–13.00)	0.1
Open RP only				
Intraoperative complications	1.23 (1.02–1.47)	0.03	1.19 (0.86–1.77)	0.4
Postoperative complications	0.92 (0.86–0.99)	0.02	0.77 (0.65–0.90)	0.001
pLOS	0.76 (0.72–0.80)	<0.001	0.90 (0.78–1.04)	0.2
In-hospital mortality	0.94 (0.43–2.09)	0.9	3.11 (0.76–12.71)	0.1

subgroup.

HV: hospital volume, OR: odds ratio, CI: confidence interval, pLOS: prolonged length of stay, CCI: charlson comorbidity index, RP: radical prostatectomy