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**Same-day Discharge versus Inpatient Robotic Assisted Radical Prostatectomy:
Complications, Time-Driven Activity-Based Costing, and Patient Satisfaction**

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Abstract

Purpose: Historically, robotic assisted radical prostatectomy (RARP) is accompanied by an inpatient hospital admission. The COVID-19 pandemic necessitated a transition to same-day discharge RARP in some centers to free up critically needed inpatient beds. This study aims to compare complications, total healthcare costs, and patient satisfaction for same-day discharge vs. inpatient RARP.

Materials and Methods: We compared 392 consecutive RARPs performed as same-day discharge (n=206) vs. inpatient (n=186) from February 2020 to November 2022 at two academic medical centers. We utilized propensity score analysis to assess the impact of same-day discharge vs. inpatient RARP on 30-day complications (primary outcome). Time-driven activity-based costing (TDABC) analysis was applied to compare total costs of RARP care, and we administered a validated Patient Satisfaction Outcome Questionnaire (PSOQ) to compare satisfaction scores.

Results and Conclusions: Inpatient RARP patients were more likely to be older, self-reported Black race or Hispanic ethnicity, and have higher American Society of Anesthesiologists (ASA) classification. Complication rates were non-significantly lower for same-day discharge vs. inpatient RARP (Odds Ratio [OR] 0.87, 95% Confidence Interval [CI] 0.35 to 2.21; p=0.8). Same-day discharge vs. inpatient RARP demonstrated a \$2,106 (199%) overall cost reduction. Median satisfaction survey scores were similar and a clinically significant difference can be excluded. Same-day discharge RARP is cost-effective and should be the preferred approach in appropriately selected patients.

Introduction

Approximately 60,000 men—one-third of those with localized prostate cancer—undergo radical prostatectomy annually.^{1,2} Robotic assisted radical prostatectomy (RARP) currently comprises 85-90% of all radical prostatectomies.^{3,4} While RARP traditionally requires an inpatient admission, the feasibility of same-day discharge (SDD) RARP without overnight stay was first reported in 2010,⁵ and a few studies demonstrate similar outcomes.^{5,6}

The COVID-19 pandemic caused critical hospital bed shortages. As a result, we switched to SDD RARP and continue to offer it, creating an opportunity for comparison. As such, we sought to be the first to compare SDD vs. inpatient RARP complications (primary outcome), healthcare costs, and patient satisfaction (secondary outcomes). We used time-driven activity-based costing (TDABC) to determine the actual cost of care delivery by modeling the costs of all involved personnel, equipment, facility, and support resources per unit time.⁷ We hypothesized that SDD would not increase 30-day complications, readmissions, or patient satisfaction, while significantly reducing healthcare costs.

Materials and Methods

We performed a retrospective study of a cohort of 392 consecutive RARPs (206 SDD, 186 inpatient) performed by JCH (NewYork-Presbyterian/Weill Cornell Medical Center [NYP]) and AAL (Dell Seton Medical Center [Dell] at University of Texas Austin) from February 2020 through November 2022. The study was approved by our Institutional Review Board (Protocol 1403014960).

During the COVID-19 pandemic from March to September 2020, all RARPs at NYP were performed SDD. Hospital policy eventually allowed elective inpatient procedures, and patients chose between overnight stay vs. SDD. Patient choice at NYP was captured prospectively beginning in January

2022. At Dell, patients were allowed to choose SDD if they had a caretaker at home; those who lived alone underwent inpatient RARP.

Race and ethnicity were self-reported. We report these characteristics due to variation in populations served by our centers and to discern whether there were disparities in postoperative care. Comorbidities were captured using American Association of Anesthesiologists (ASA) classification, and complications were stratified using Clavien-Dindo classification.⁸ In patients with more than one complication, multiple algorithms were used to conduct analyses based on mutual exclusivity or highest Clavien-Dindo score. RARP was performed as previously described.⁹ There were no comorbidity or ASA class criteria that mandated the inpatient approach, and there were no exclusion criteria for this study.

The postoperative analgesic protocol included intravenous (IV) ketorolac in the post-anesthesia care unit (PACU) and for inpatient stays. Additionally, oral acetaminophen, ibuprofen, and/or cyclobenzaprine were prescribed for both SDDs and inpatients alike. Dell patients also received a transversus abdominus plane (TAP) block in the operating room with 20 milliliters of 0.25% bupivacaine.

Regarding our key question, an association between RARP postoperative care and complications would most plausibly be explained by either a causal effect of the approach or by differences in case mix. Given the small number of events relative to the number of covariates, propensity score methods were utilized for the odds of 30-day complications. We used a logistic regression model to calculate the propensity of undergoing SDD vs. inpatient based on age, BMI, race/ethnicity, and comorbidities, then weighted each patient's data based on the inverse propensity of being in one of the two treatment groups. Covariate balance was checked after adjustment. Covariates were also separately

analyzed on univariate models to determine association with complications. Statistical analysis was performed using SAS version 9.4 (SAS Institute, Cary, NC, USA).

We modified a Patient Satisfaction Outcome Questionnaire (PSOQ) previously validated for orthopedic surgery and administered it starting in February 2021 within 30 days postoperatively (n=62 SDD, n=49 inpatient) to compare satisfaction and pain.¹⁰ Survey modifications included changes to the specific surgical procedure performed (Appendix). For instance, “robotic radical prostatectomy” replaced “anterior cruciate ligament reconstruction” and “catheter care” replaced “physical rehabilitation.” Items focused on patient perceptions of the effectiveness of pain control, medication side effects, and overall satisfaction with the surgery and recovery process. Responses on the PSOQ were scored on a scale ranging from 0 to 100. Higher scores represent better outcomes for items concerning drug effectiveness; lower scores represent better outcomes for items concerning side effect severity. We performed a Wilcoxon rank-sum test, with the 95% CI for difference in medians calculated using the Hodges-Lehman estimator.

To derive the costs for RARP, we implemented the TDABC method as previously described by Kaplan et al.¹¹ We assembled stakeholders to develop process maps of steps in delivering care for RARP.¹² Next, we traced the RARP care timepoints from time of hospital arrival, time in preop, time in the operating room, beginning and end of anesthesia, beginning and end of case, time in the PACU, and time on the inpatient floor/observation unit before discharge. We then calculated the average time spent in each phase. The capacity cost rate was determined for every resource involved in the process maps.¹² Finally, the summation of the cost of each process in the pathway was calculated, resulting in the total average cost of care for SDD and inpatient RARP. For SDD patients who were unexpectedly admitted overnight, we utilized an intention-to-treat analysis and calculated the

admission cost by multiplying the probability of an added overnight admission ($6/206=3\%$) by the cost of inpatient admission.

Results

Baseline patient characteristics for the multicenter pooled sample are shown in Table 1. There were some significant differences in race/ethnicity and comorbidities, largely driven by diabetes and hypertension, but these were moderate in size: 35% vs. 48% were ASA 3-4 and 51% vs. 46% self-identified as White race for same-day vs. inpatient, respectively. Eighty-seven percent of men at NYP and 47% men at Dell opted for SDD when offered the choice.

Procedural time and complications are shown in Table 2. Procedure times were longer at Dell, but PACU time at Dell was shorter. Dell does not have a phase III PACU, necessitating a significantly shorter PACU stay.¹³ Inpatients experienced statistically significant longer operative times and shorter PACU times, possibly due to a relatively larger influence of inpatients at Dell. Complication rates were low and similar in each arm. Clavien-Dindo grade II events included urinary tract infection and other infections requiring antibiotics. Grade III complications included a symptomatic lymphocele requiring hospital admission and interventional radiology drainage in an inpatient RARP, and one SDD RARP developing a port-site strangulated hernia requiring laparoscopic repair. There were three (1.6%) readmissions following inpatient RARP four (1.9%) readmissions following SDD RARP.

There were no statistically significant differences between groups for the covariates after adjusting for propensity score (all p values >0.8). Moreover, both inpatient and SDD were represented across the distribution of potential confounders with only one patient having a propensity score of >90% or less than 10% (92%). In the main analysis, after adjusting for propensity score, there were slightly, though non-significantly, fewer complications in the SDD vs. inpatient RARP in the propensity score analysis

(OR 0.87, 95% CI 0.35, 2.21; $p=0.8$). Table 3 shows that there are not strong associations between complications and any of the variables that differed between groups. The only statistically significant predictor of complications was BMI, which was similar between groups.

Patients responded overwhelmingly positively to survey items about pain control in the hospital, pain control at home, severity of side effects from pain medications during treatment, and overall satisfaction with the treatment. The median scores for these questions were 97-100 (out of a maximum of 100) for both groups. Patients assigned low scores to the question about stress due to uncontrolled pain after surgery, for a median of 10 for both groups. There was no difference in survey scores ($p >0.05$) for any item (Table 4), and for three of the five questions, a clinically relevant difference could be excluded. Analysis was repeated with patient satisfaction being dichotomized and the findings were unchanged.

In terms of TDABC (Table 5), preoperative visit costs (\$287) were similar. The most substantial differences were in RARP and overnight admission costs. The average cost of the RARP procedure was an average of \$7,777 for SDD and \$8,915 for inpatients. The average cost of overnight admission for an inpatient was \$963. There was a small cost (\$39) of inpatient admission for SDD to account for those who had an unplanned overnight stay. The net difference was \$2,106 in favor of SDD for a cost savings approximating 19% (Table 5).

Discussion

We found that SDD after RARP lowered healthcare costs without a clinically relevant increase in complications or decrease in patient satisfaction. The upper bound of the 95% CI for complications was an odds ratio of 2.21. While residual confounding cannot be excluded, overall low complications entail that any increase in the absolute risk of complications caused by SDD will be small.

These findings confirm studies highlighting comparable safety and outcomes of SDD RARP,¹⁴⁻¹⁶ but our study is the first to also compare patient satisfaction using a validated instrument as well as healthcare costs, using the most accurate methodology. In a small 2016 study of 30 men undergoing RARP, 26 discharged same-day were comparable to four patients who stayed overnight in terms of narcotic usage days, days to return to work, and continence at 2 months.⁶ A more recent and much larger study of 258 SDD and 1,290 inpatient RARPs compared the risk of early postoperative mortality, morbidity, reoperation, and readmission and found no significant difference.¹⁷ Overall morbidity was 3.1% vs. 4.7%, RR 0.65, 95% CI 0.32-1.35, reoperation rate was 2.3% vs. 0.6%, RR 1.82, 95% CI 0.63-5.28, and readmission rate was 2.6% vs. 3.9%, RR 0.5, 95% CI 0.30-1.55 in this study.¹⁷ A French multi-institutional assessment of SDD for RARP also found a low readmission rate (2.8%), further supporting the safety and feasibility of SDD RARP.¹⁵

Another study of SDD RARP from 2006 to 2016 found that over 70% of the SDDs were done after 2012, which demonstrates its increasing popularity over time.¹⁷ An additional study found a 65% preference for SDD RARP.¹⁶ Compared to these studies, our NYP patients preferred SDD at a higher rate. We surmise that during the COVID-19 pandemic, patients may have become more wary of the risk of nosocomial infections, resulting in a preference to recover at home rather than in the hospital if reasonable. Additionally, as SDD RARP has become more common and “normalized,” more patients might be willing to choose this option. These numbers for SDD were lower at Dell largely due to differences in the patient population: one-third are uninsured/underinsured with many traveling several hours to the hospital, contributing to additional social factors that make SDD challenging. Furthermore, the lack of a phase III PACU meant patients had at most 2-3 hours before needing to be admitted or discharged. Whereas previous studies showed a higher likelihood of SDD for patients undergoing RARP earlier in the day,¹⁶ all planned SDD patients were discharged on the same day in

our study, regardless of case order, and up to three RARPs were performed daily. This difference may be a consequence of our patients selecting SDD surgery in a pre-planned fashion, as opposed to the aforementioned study which offered it to patients both before and after surgery.

One potential reason for consistently high patient-reported outcomes on pain is our standardized postoperative pain regimen. A multimodal, non-opioid pain regimen which includes non-steroidal anti-inflammatory drugs, acetaminophen, and local anesthetics is recommended by the American Urological Association to reduce opioid usage.¹⁸ A recent large national cohort study identified IV ketorolac as the strongest predictor of opioid-sparing radical prostatectomy.¹⁸ Postoperative pain control for all of our RARPs were opioid-sparing—patients received two doses of IV ketorolac: one at the time of incision and another in the PACU. We found no significant differences in postoperative pain and patient satisfaction scores between SDD and inpatient RARPs.

This is the first study to demonstrate that SDD is 19% (or approximately \$2,000 per patient) less expensive than inpatient RARP without affecting 30-day complications, readmissions, or patient satisfaction. Although it may be self-evident that SDD vs. inpatient RARP significantly reduces healthcare costs, the mapping and quantification of phases of care generates targets for additional cost reduction. For example, after reviewing various interims throughout the process, we reduced patient PACU times by administering the first dose of ketorolac at the start of the procedure to minimize the duration until second ketorolac dose in the PACU prior to discharge. Moreover, health systems pivoting toward value-based care must factor in a SDD approach to RARP when using TDABC to compare radical prostatectomy to alternatives such as active surveillance, radiation therapy, or partial gland ablation.^{12,19} Our multicenter study provides contemporary and more generalizable SDD RARP TDABC analyses for this purpose.

Annual RARP cases in the United States are estimated to range from 48,600 to 55,400, yielding a cost savings of approximately \$102 to \$116 million per year if calculations are scaled nationally when converting RARP to SDD.²⁰ Moreover, on an individual surgeon level, some health systems incentivize surgeons for efficiency. In such scenarios, SDD savings may be offered as surgeon bonuses to further incentivize physician buy-in.²¹ Finally, there is an indirect revenue benefit from SDD beyond our TDABC-derived cost savings that results from freeing the use of the inpatient personnel, beds, labs, and personnel for other medical conditions.

With respect to causal attribution, we can leave aside the question of costs, for which the causal pathway is obvious. This leaves the question of whether SDD may in fact lead to an increased risk of 30-day complications, but this was not observed due to confounding. We find this scenario unlikely as there were not large between-group differences for measured covariates, no strong associations between those covariates and outcome, and our main analysis was adjusted.

TDABC analysis at large academic centers in major metropolitan areas may not necessarily generalize to health systems located in other regions. Although we estimate the lower costs of SDD RARP, we do not quantify the benefit of an additional bed capacity that enables other surgeries or medical therapy for other conditions. In addition, the two institutions handled the decision of SDD vs. inpatient differently—SDD surgery was only an option at Dell if patients had caregivers at home. Alternatively, a strength of our study is that these two academic centers cater to very different patient populations from a sociodemographic perspective. Whereas NYP treats a large percentage of Medicare and commercially insured patients, Dell is a hybrid of a county/insured hospital mixed with private/government payers. Another strength of our study is that it encompasses two different populations of patients who underwent surgery with surgeons of varying experience—one with 18 years of RARP experience and one who recently finished fellowship at the start of the study.

Conclusion

Our multi-institutional evaluation of SDD vs. inpatient RARP showed cost savings associated with SDD while maintaining similar satisfaction levels and no difference in complications, even across institutions and differing surgeon experience. The majority of patients preferred a SDD approach when given the choice. These data provide evidence that SDD RARP improves value-based care with comparable outcomes at significantly lower healthcare costs. It should be the preferred approach for appropriately-selected patients. Future investigation should explore linking TDABC calculations to patient experience and post-surgical outcomes.

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Table 1. Baseline patient demographics and characteristics. Data are given as median (quartiles) or frequency (%). “Other” includes patients who self-reported “other” as race and those who declined to self-report. Continuous variables were compared using non-parametric Wilcoxon rank sum test. Categorical variables were compared using the Fisher Exact test.

	NYP	Dell	p-value	Inpatient	Same-day discharge	p-value
	n = 258	n = 134		n=186	n=206	
Age	66 (60-71)	63 (59-67)	0.002	65 (59-71)	65 (59-70)	0.4
BMI, kg/m ²	26.5 (24.3-28.8)	27.3 (24.5-30.6)	0.039	26.8 (24.5-30.1)	26.6 (24.3-28.6)	0.14
ASA 3-4	84 (33)	78 (58)	<0.001	90 (48)	72 (35)	0.008
Race			<0.001			<0.001
White	113 (44)	78 (58)		86 (46)	105 (51)	
Black	28 (11)	23 (17)		33 (18)	18 (8.7)	
Asian	67 (26)	3 (2.2)		17 (9.1)	53 (26)	
Hispanic	4 (2)	20 (15)		17 (9.1)	7 (3.4)	
Other	46 (18)	10 (7.5)		33 (18)	23 (11)	
Comorbidities						
Coronary artery disease	49 (19)	11 (8.2)	0.005	26 (14)	34 (17)	0.6
Hypertension	134 (52)	84 (63)	0.054	114 (61)	104 (50)	0.033
Diabetes mellitus	35 (14)	23 (17)	0.4	35 (19)	23 (11)	0.045
Chronic kidney disease	11 (4.3)	1 (0.7)	0.066	6 (3.2)	6 (2.9)	1

Table 2. Procedural time and complications. Wilcoxon rank-sum test and Fisher Exact test were performed.

		NYP (n = 258)	Dell (n = 134)	p-value	Inpatient (n=186)	Same-day discharge (n=206)	p-value
Procedure time, minutes	Median (IQR)	173 (152-202)	242 (223-268)	<0.001	222 (180-251)	184 (153-218)	<0.001
PACU time, minutes	Median (IQR)	314 (258-391)	74 (60-103)	<0.001	141 (68-271)	300 (221-357)	<0.001
Total length of stay, minutes (PACU + admission)	Median (IQR)	388 (299-1015)	1259 (154-1441)	<0.001	1266 (824-1516)	322 (271-388)	<0.001
Readmissions, n (%)		4 (1.6)	3 (2.2)	0.7	3 (1.6)	4 (1.9)	1
Clavien-Dindo complication rate, n (%)							
Take the higher score if multiple, mutually exclusive	Grade 2	13 (5.0)	4 (3.0)		8 (4.3)	9 (4.4)	
	Grade 3	2 (0.8)	5 (3.7)		4 (2.2)	3 (1.5)	
Not mutually exclusive	Any CD=2	13 (5.0)	5 (3.7)		9 (4.8)	9 (4.4)	
	Any CD=3	2 (0.8)	5 (3.7)		4 (2.2)	3 (1.5)	

Table 3: Association between potential confounders and 30-day complications. Univariate Logistic regression and Wald Chi-Square test were performed.

30-Day Complications			
Variable	Odds ratio	95% CI	p-value
Univariate analysis (referent)			
NYP (Dell)	0.88	0.37, 2.06	0.8
Race (White)			
Asian	0.93	0.20, 4.36	0.9
Black	1.40	0.33, 5.90	0.6
Hispanic	0.72	0.08, 6.75	0.8
Other	1.11	0.34, 3.55	0.9
Chronic Kidney Disease (no)	1.39	0.17, 11.25	0.8
Coronary Artery Disease (no)	0.49	0.11, 2.13	0.3
Diabetes (no)	1.99	0.76, 5.26	0.2
Hypertension (no)	0.93	0.41, 2.13	0.9
BMI	1.13	1.03, 1.23	0.012
Age	1.05	0.99, 1.11	0.12
SDD (inpatient) [unadjusted]	0.9	0.39, 2.05	0.8
SDD (inpatient) [propensity score weighted]	1.08	0.47, 2.49	0.9
Readmission			
SDD (inpatient) [unadjusted]	2.29	0.44, 11.94	0.3
SDD (inpatient) [propensity score weighted]	3.65	0.6, 22.33	0.2

Table 4. Median patient-reported satisfaction scores and pain scores. Scores ranged from 0-100. Wilcoxon rank-sum test was performed. *95% CI by Hodges-Lehman estimator.

Patient satisfaction items, selected for relevance	Inpatient (IQR) [n=49]	Same-day discharge (IQR) [n=62]	Difference in median [95% CI]*	p-value
Overall satisfaction with entire course of treatment (to 2 weeks post-operatively), median	100 (100-100)	100 (100-100)	0 [-0, 0]	0.2
Overall pain control in the hospital, median	100 (100-100)	100 (95-100)	0 [0, 0]	0.7
Overall pain control at home, median	100 (75-100)	97 (80-100)	2 [-6, 10]	0.9
Stress due to uncontrolled pain after surgery, median	10 (0-50)	10 (0-35)	0 [-16, 16]	0.9
Severity of side effects from pain medications during entire course of treatment, median	100 (0-100)	100 (0-100)	0 [-33, 33]	0.9

Table 5. Mean TDABC cost breakdown between inpatient and same-day discharge RARP. All prices in USD.

Breakdown of costs	Same-day discharge (n=206)	Inpatient (n=186)
Preop	287	287
RARP	7777	8915
PACU	895	939
Admission	39	963
Total cost	8999	11104
Cost difference (net)	-2106	
Cost difference (% decrease)	-19	