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Trends in immediate perioperative morbidity and delay in discharge after open and minimally invasive radical prostatectomy (RP): a 20-year institutional experience

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Abstract

- To investigate the development of the clinical care pathway to discharge after radical prostatectomy (RP) at a large, academic medical centre over the past 20 years, focusing on the rates and reasons for deviation.
- In all, 18 049 men were identified from the Johns Hopkins RP database who had undergone surgery since 1991.
- Patients in whom the length of stay (LOS) was 95th percentile, defined the clinical care pathway to discharge and those in whom LOS was 98th percentile were termed 'off-pathway'.
- The mean LOS decreased from 7.7 days in 1991 to 1.6 days in 2010.
- Of 7126 patients undergoing RP since 2005, 1803(25.3%), 4881(68.5%) and 312 (4.4%) were discharged on postoperative day (POD) 1, 2 and 3, respectively; 126 (1.8%) patients, discharged on POD4–21 were 'off-pathway'.
- The most common reasons for delay of discharge were ileus (44, 0.615%), urine leak (12, 0.17%), anaemia requiring blood transfusion (nine, 0.126%) and bleeding requiring re-exploration (six, 0.08%).
- The proportion of patients 'off-pathway' was 1.20%, 1.06% and 4.01% for retropubic RP (RRP), laparoscopic RP (LRP) and robot-assisted laparoscopic RP (RALRP), respectively ($P < 0.001$).
- Ileus delayed discharge in 0.28%, 0.37% and 1.9% of patients undergoing RRP, LRP and RALRP, respectively ($P < 0.001$).
- The clinical care pathway to discharge after RP has changed dramatically at our institution over the past 20 years.
- RALRP appears to result in a higher proportion of 'off-pathway' patients, primarily due to ileus, compared with RRP and LRP. However, very few patients were discharged 'off-pathway'.

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Conflict of interest

None.

Keywords

prostate cancer; radical prostatectomy; clinical care pathway; outcomes; morbidity

Introduction

In an effort to improve patient care, patient satisfaction and the cost-effectiveness of large scale surgeries, standard clinical care pathways to discharge have been established for several operations including radical prostatectomy (RP) [1, 2]. The pathway after RP has changed dramatically over the past two decades due to improvements in surgical technique, anaesthesia and most recently, the introduction of minimally invasive RP (MIRP). In 2000, Gardner *et al.* [3] described a clinical care pathway to discharge after RP of 5 days; more recent publications report reductions in the pathway to 3 and 2 days with the introduction of robot-assisted laparoscopic RP (RALRP) [4, 5].

Prior studies defined the postoperative pathway based on institutional data, evaluated predictors of increased length of stay (LOS), complication and readmission rates, and compared open and MIRP [2–5]. Therefore, it was not the goal of this analysis either to repeat the work of prior studies by investigating complications or readmissions after RP. Rather, the primary goal of the present analysis was to examine the changes in the care pathway after RP over 20 years at a major academic centre renowned for RP, and to investigate the causes of immediate, perioperative morbidity and their influence on ‘off-pathway’ prolonged hospitalisation.

Patients and methods

The Johns Hopkins RP Database was queried; 18 049 men were identified who underwent RP for adenocarcinoma of the prostate since 1991. It is our institutional practice pattern that all patients undergoing RP undergo a lymphadenectomy. The LOS was evaluated by year to identify trends in hospital admission and discharge before and after RP. Patients who underwent perineal prostatectomy (23 patients) or previous reconstructive surgery of the urinary tract (three; bladder extrophy, complex hypospadias, urethrectomy) were excluded.

Clinical care pathway to discharge after RP and definition of ‘off-pathway’

The postoperative, clinical care pathway after RP has changed dramatically over the past 20 years at our institution. In the mid- and early-1990s patients were kept *nil per os* until having a bowel movement. Patients were admitted 1 day before surgery for bowel preparation and preoperative laboratory evaluation consistently until 1999. Since 2005, our institution has used a consistent 1–2 day clinical care pathway to discharge after RP, regardless of surgical approach. The pathway consists of patient-controlled-anaesthesia, clear liquid diet and ambulation on the night of surgery; transition to oral pain medications, solid food and a minimum of four ambulatory sessions on postoperative day (POD)1. Patients are given a suppository and started on a bowel regimen of mineral oil and milk of magnesia on POD1. Ketorolac is given on the day of surgery or POD1 at the discretion of the attending surgeon. All RP patients are educated about catheter care and recovery expectations by trained nursing staff. Patients are given the option of discharge on the afternoon of POD1, if tolerating a regular diet and ambulating without issue. Surgical drains are removed before discharge on patients without frank anastomotic urine leak. Urine leak is defined as a drain output of > 100 mL with creatinine content indicative of urine. While some patients may choose to remain in the vicinity of the hospital for an additional day or days after discharge, out-of-town patients are allowed to travel immediately upon discharge.

'Off-pathway' patients (those with prolonged LOS) were defined as those whose LOS was > 98th percentile. Reasons for falling 'off-pathway' were identified; new diagnoses, complications and interventions were catalogued. All complications were graded by the Clavien grading system [6]. Ileus was defined by the clinical scenario of abdominal distension and/or discomfort with the inability to tolerate a regular diet without evidence of frank intestinal obstruction.

Predictors of 'off-pathway' discharge were investigated in the most contemporaneous patient cohort from 2005–2011. Appropriate comparative statistics and logistic regression modelling were used to determine predictors of 'off-pathway' discharge. Cases were numbered sequentially for each operating physician in order to define surgeon experience. Significant predictors of 'off-pathway' discharge in univariate analysis were included in the multivariable analysis.

Results

Trends in days to discharge over the past 20 years (January, 1991 to March, 2011) are detailed in Figures 1 and 2. The mean postoperative LOS decreased from 7.7 days in 1991 to 1.6 days in 2010. For the period 1991–1996 and 1997–2004 the corresponding definitions of clinical care pathway to discharge (95th percentile) were 7 and 3 days respectively; 'off-pathway' patients (98th percentile) constituted those staying 9 days and 5 days during each period, respectively (Figure 2). Of 7126 patients undergoing RP since 2005, 1803 (25.3%), 4881 (68.5%) and 312 (4.4%) were discharged on POD1, 2 and 3, respectively. Patients discharged on POD3 or earlier totalled 98.2% of the population undergoing RP during this period. The remaining 126 (1.8%) patients, discharged on POD4–21 were considered 'off-pathway'.

The patient and prostate cancer characteristics are detailed in Table 1. Most patients were aged 50–60 years and Caucasian with low-risk (clinical stage T1c or T2a, PSA level of < 10ng/mL, biopsy Gleason < 7) prostate cancer. Since 2005, the open retropubic RP (RRP) group, despite having a higher proportion of men with T1c disease, had a greater proportion of men with Gleason 7 disease at biopsy and at RP, a greater proportion of men with extraprostatic disease (pT3a, pT3b or N1), and a lower rate of positive surgical margins.

Trends in LOS, 'on-pathway' and 'off-pathway' patients

Of 18049 men undergoing RP between 1991 and 2011, 15360 (83.8%) were RRP, 1263 (6.9%) were laparoscopic RP (LRP) and 1426 (7.8%) were RALRP. Interestingly, the mean LOS decreased from 7.7 days in 1991 to 3.0 days in 1999, and remained stable (range 2.87–3.08 days) until 2004 before resuming a decreasing trend (Figure 1). This period coincides with the emergence of MIRP at our institution. In 2005, RRP constituted 75% of all RPs performed at our institution. Since 2005, that proportion has decreased to 60%, the rate of LRP has remained relatively stable at ≈10%, and RALRP has increased from 14% to 30% of RPs performed. The median LOS reached 2 days for RRP, LRP and RALRP in 2005 and the mean LOS reached < 2 days in 2007 for all three approaches.

Since 2005, the mean LOS for RRP, LRP and RALRP was 1.87, 1.68 and 1.96 days, respectively ($P < 0.001$ for all interactions). During this period there were several statistically significant differences among patients undergoing RRP, LRP and RALRP; however, these differences in patient and prostate cancer characteristics are sufficiently small and have questionable clinical significance in predicting LOS (Table 1). Notably, more surgeons performed RRP (15 surgeons) than LRP (two) or RALRP (six); and surgeons performing RRP were considerably more experienced (average case number 1841 from

2005–2011 vs 506 and 394 for LRP and RALRP, respectively) than surgeons performing LRP or RALRP.

Of 126 ‘off-pathway’ patients since 2005, the most common reasons for delay of discharge were ileus (44, 0.615%), urine leak (12, 0.17%), anaemia requiring blood transfusion (nine, 0.126%) and bleeding requiring re-exploration (six, 0.08%). The proportion of patients ‘off-pathway’ was 1.20%, 1.06% and 4.01% for RRP, LRP and RALRP, respectively ($P < 0.001$). The primary reasons for delayed discharge and total complications are detailed in Table 2. Of note, RP-specific complications including postoperative anaemia requiring transfusion, operative and non-operative urine leak, as causes of delay in discharge were more common in RALRP than RRP or LRP. RRP had a greater proportion of men with haematuria requiring irrigation; however, rates of re-operation for bleeding were similar among RRP and RALRP. General surgical or anaesthesia-related complications were similar among all approaches with the exception of ileus, which was higher in the RALRP cohort. For patients with ileus, there was no difference in the LOS or use of a nasogastric tube based on approach. Interestingly, five patients undergoing RRP had a deep venous thrombosis (DVT) or pulmonary embolus in the immediate perioperative period, one patient undergoing LRP developed a DVT and no patients undergoing RALRP had a thrombotic event while hospitalised. ‘Off-pathway’ patients had a mean (range) of 1.2 (1–3) complications during hospitalisation. In nine patients, no complication could be attributed to the increased LOS. Of those patients with a complication contributing to an increased LOS, 46 (39.6%), 35 (30.2%), 16 (13.7%) and 18 (15.5%) patients had a Clavien grade I, II, III and IV complication, respectively. One patient (0.9%) died on POD5 due to sequelae of an aspiration event and acute respiratory distress syndrome.

The patient and prostate cancer characteristics for the men ‘on-pathway’ and ‘off-pathway’ are detailed in Table 3. Of note, men discharged ‘off-pathway’ were more often African-American, underwent RALRP and on average, had less experienced surgeons. In univariate logistic regression, significant predictors of an ‘off-pathway’ discharge included age, African-American race, surgeon experience and surgical approach. Of note, body mass index (BMI) and Charlson comorbidity index (CCI) did not predict an ‘off-pathway’ discharge. Importantly, the vast majority of patients had a CCI of 0 or 3, indicating an overall very healthy cohort. Multivariable analysis is detailed in Table 4. Of note, age and African-American race increased the likelihood of ‘off-pathway’ discharge; in addition, patients undergoing RALRP had greater than twice the risk of being discharged ‘off-pathway’. Finally, the likelihood of being discharged ‘off-pathway’ was mitigated by surgeon experience (hazard ratio 0.9998). Most ‘off-pathway’ discharges, 1681 of 1973 (85.2%) in the entire cohort, and 91 of 138 (65.9%) since 2005, occur in the first 1000 cases of a surgeon’s experience.

Discussion

As described in other series, we have seen a decrease in the LOS in the clinical care pathway after RP over the last 20 years.[3–5]. In examining these data, the role of MIRP in shaping this trend is evident and in the overwhelming number of cases (> 98%), an accelerated hospital recovery pathway of 1–2 days is successful, regardless of surgical approach. In the few men who deviate from the postoperative pathway, we investigated preoperative and intraoperative factors that determined their outcome in the hope of providing realistic expectations of recovery after RP for patients and physicians alike.

The dramatic decrease in the LOS and definition of the clinical care pathway to discharge after RP is evident as the mean LOS decreased from 7.7 days in 1991 to 1.8 days in 2011. Factors influencing this trend include improvements in the knowledge of prostatic anatomy

and surgical technique pioneered by Walsh [7], which have improved blood loss during the operation, decreased the rate of blood transfusion (from 62–89% in the 1980s to 0.8–3.4% most recently) and improved patient convalescence; improvements in anaesthesia and postoperative analgesia; a physician- and patient-driven move toward earlier discharge based on the knowledge that increased hospital time increases the risk of nosocomial infections and iatrogenic morbidity; and finally, the difficult economic environment and attempts to decrease healthcare costs.

A second trend involves a more subtle decrease from 3 to < 2 days in the subsequent and most recent 10 years. In addition to the factors discussed above, the decrease in the LOS in this trend coincides with the emergence of MIRP globally and at our institution. Our institution is one of few to have the unique experience of large-volume RRP, RALRP and standard LRP that preceded the use of robotic systems. One of the proposed benefits of MIRP is the improved recovery time and in an effort to promote its use, more aggressive discharge strategies were adopted including early ambulation, limiting narcotics and improved patient counselling [8–10]. Consistent with the views of other groups [5], we hypothesise that aggressive discharge strategies associated with MIRP and the demonstration that patients could be safely discharged probably influenced the adoption of a shortened pathway for all patients undergoing RP.

In the overwhelming number of cases, an accelerated hospital recovery pathway of 1–2 days is successful regardless of surgical approach. In the few cases of deviation from the postoperative pathway, the most common reasons included ileus, anaemia, blood transfusion or bleeding, haematuria and urine leak. The proportion of patients with each reason for deviation differed among surgical approach. RALRP was the greatest risk factor for ‘off-pathway’ discharge and this may have been driven by a nearly seven-fold increase in ileus in patients undergoing RALRP when compared with RRP or LRP. It is our hypothesis, that most morbidity, particularly ileus, after RALRP is related to the transperitoneal approach (of note, > 70% of the LRP were performed with an extraperitoneal approach) and the exposure of the abdominal viscera to a chemical irritant where urine leak was present. This may explain the apparent increased rate of urine leak in the RALRP cohort when, in fact, rates of urine leak after each approach may be remarkably similar (as it is not routine practice at our institution to examine patients with a cystogram before catheter removal, many patients undergoing an extraperitoneal approach may have ‘silent’ urine leaks). In addition, abdominal insufflation with CO₂ has been shown to alter peritoneal integrity, alter the local immune response and create acidosis due to decreased local oxygen pressure [11] and may offer an alternative explanation for increased abdominal morbidity after RALRP. Further, differences in positioning (i.e. steep Trendelenburg) may effect rates of ileus, as transperitoneal laparoscopic renal surgeries, specifically laparoscopic partial nephrectomy, which is known to have a urine leak rate of 4–14%, has a very low rates of ileus reported [12, 13]. Finally, higher rates of ileus may reflect longer operative durations as this analysis contrasts a mature RRP experience with the initial cases of RALRP for some surgeons.

Despite the widespread adoption of RALRP across the USA, patient satisfaction after RALRP can be worse when compared with open RP. Schroeck *et al.* [14] reported decreased satisfaction and regret in patients who had complications and underwent RALRP when compared with those without complications and those undergoing RRP. Part of the blame for the dissatisfaction with RALRP has been attributed to heightened expectations after robotic surgery, specifically with regards to sexual potency [15]. While a minority of patients undergoing RP will have an ‘off-pathway’ discharge, the expectation of a shorter LOS and convalescence [16, 17] may disproportionately contribute to patient dissatisfaction or regret in patients undergoing RALRP.

In addition to use of RALRP, African-American race also predicted 'off-pathway' discharge. While race/ethnicity is not an intuitive determinant of perioperative morbidity or discharge patterns, it may reflect worse prostate cancer characteristics, socioeconomic status and less exposure to healthcare before surgery, which in turn leads to worse baseline health status and longer hospitalisation. Despite this possibility, African-American race remained a substantial predictor of longer hospitalisation despite controlling for CCI, BMI and tumour characteristics. However, the rates of specific complications were similar among African-American and Caucasian men. It is possible that complications are more frequent in this population due to less favourable pelvic anatomy but this issue warrants further study and will be the subject of another report.

Surgeon experience is certainly an important predictor in perioperative, oncological and functional outcomes after RP [17–20]. It has also been shown that the LOS decreases with increasing experience [16, 19]; undoubtedly as surgeons decrease not only their complication rate, but their familiarity with post-RP patients and their issues. While we found a protective effect with greater surgeon experience it was of minimal magnitude. The small effect of surgeon experience on 'off-pathway' discharge in the present series may be explained by the extensive exposure to RP of our faculty during residency training, that relatively inexperienced surgeons in this series are operating a high-volume, centre of excellence for RP, and may not reflect the true role of experience in determining pathway discharges in urology practices at large.

There are several additional important limitations of the present analysis. First, as this analysis describes deviation from a standard postoperative recovery, it does not provide the complete picture of postoperative morbidity after RP. Additionally, there are several biases that may affect deviation from the standard postoperative pathway. For instance, individual surgeons may have preferences for discharge that are not captured in this analysis. Similarly, the LOS may vary between institutions and internationally as it depends on institutional biases, financial impetus including the local healthcare system and patient expectations, which certainly vary culturally. Therefore the LOS, as an exact outcome measure, may not be able to be fairly compared among institutions, especially international sites. However, other institutions may see similar trends including the decrease in the LOS that coincides with the emergence of MIRP. Another criticism is cohort size, as <2% of patients in the most contemporary cohort, regardless of surgical approach, fall 'off-pathway'. Nevertheless, these data show realistic outcomes and expectations for patients choosing open and minimally-invasive surgical methods for the LOS and short-term morbidity. In addition, as we continue to seek budget-improving healthcare solutions on an institutional and national level, potentially increased LOS and short-term morbidity should be considered in future cost-effectiveness calculations for RALRP.

In conclusion, the clinical care pathway to discharge after RP has changed dramatically over the past 20 years. Most recently, the open and MIRP pathway has reached 2 days. Less than 2% of patients will fall 'off-pathway' with the most common reasons being anaemia or bleeding-related, urine leak and ileus. Patients undergoing RALRP had an increased rate of ileus that prolonged hospitalisation when compared with patients undergoing RRP or LRP and this is probably due to an intraperitoneal approach.

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Abbreviations

BMI	body mass index
CCI	Charlson comorbidity index
DVT	deep venous thrombosis
LOS	length of stay
POD	postoperative day
(L)(MI)(RAL)(R)RP	(laparoscopic) (minimally invasive) (robot-assisted laparoscopic) (open retropubic) radical prostatectomy

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What's known on the subject? and What does the study add?

Standard clinical care pathways to discharge have been established for a number of operations including radical prostatectomy (RP). The pathway after RP has changed dramatically over the past two decades due to improvements in surgical technique, anaesthesia and most recently, the introduction of minimallyinvasive RP (MIRP).

This study adds evidence that the emergence of MIRP is associated with a decrease in LOS for all patients undergoing RP. In addition, it catalogues the development of the clinical care pathway over 20 years at a large, tertiary care hospital with extensive experience in RP. Finally, it defines the common reasons patients fall 'off-pathway' (ileus, urine leak, anaemia and re-exploration for bleeding) and defines the immediate perioperative morbidity profile of RP. Specifically, it addresses approach-specific morbidities and indicates that MIRP is associated with higher rates of 'off-pathway' discharge, most often due to ileus.

Figure 1.
Trends in the LOS after RP for 1991–2011.

Figure 2.
The percentage of patients discharged on each postoperative day. All patients undergoing RP are shown in the left column for three distinct periods (1991–1996, 1997–2004 and 2005–2011).

Patient and prostate cancer characteristics for 18 319 men undergoing RP at Johns Hopkins since 1991 and from 2005–2011 stratified by approach to RP

Table 1

Characteristic	1991–2011 Entire cohort, n=18 319	2005–2011 RRP, n=4950	LRP, n=849	RALRP, n=1422	P
Median (range) age, years	58 (33–81)	59 (34–81)	59 (36–79)	59 (35–77)	0.18
Family history, n (%)	4402 (24.0)	1950 (39.4)	267 (31.4)	547 (38.5)	<0.001 ^{ac}
Race, n (%):					<0.001 ^{abc}
African-American	1510 (8.2)	509 (10.3)	118 (13.9)	196 (13.8)	
Asian	162 (0.9)	58 (1.2)	10 (1.2)	18 (1.3)	
Caucasian	15942 (87.0)	4146 (83.8)	662 (78.0)	1147 (80.7)	
Other	706 (3.9)	237 (4.8)	59 (6.9)	61 (4.3)	
CCIScore, n (%):					0.7
0	11325 (83.9)	1588 (83.0)	304 (81.3)	229 (80.6)	
1	1748 (13.0)	274 (14.3)	58 (15.5)	45 (15.8)	
2	295 (2.2)	38 (2.0)	11 (2.9)	8 (2.8)	
3	130 (1.0)	13 (0.7)	1 (0.3)	2 (0.7)	
Median (range) BMI, kg/m ²	26.6 (13.7–56.3)	27.1 (15.1–56.3)	27.1 (14.9–47.8)	27.3 (17.6–44.4)	0.02 ^b
Clinical stage, n (%):					0.01 ^{ac}
cT1	12738 (69.5)	3743 (75.6)	582 (68.6)	1098 (77.2)	
cT2a	3455 (18.9)	752 (15.2)	142 (16.7)	220 (15.5)	
cT2b	1426 (7.8)	305 (6.2)	42 (4.9)	38 (2.7)	
cT2c or cT3	410 (2.2)	57 (1.2)	14 (1.6)	9 (0.6)	
Median (range) PSA level, ng/mL	5.5 (0.1–116)	4.9 (0.17–97.2)	5.0 (0.1–49.9)	4.8 (0.2–45)	<0.001 ^b
Biopsy Gleason sum, n (%):					<0.001 ^{ab}
2–6	13218 (72.2)	3001 (60.6)	612 (72.1)	986 (69.3)	
7	4272 (23.3)	1588 (32.1)	212 (25.0)	379 (26.7)	
8–10	791 (4.3)	346 (7.0)	25 (2.9)	55 (3.9)	
Mean (range) positive cores, n	2.93 (1–19)	3.28 (1–16)	3.01 (1–11)	2.92 (1–15)	<0.001 ^{ab}
Median (range) total cores, n	12 (1–99)	12 (1–99)	12 (1–24)	12 (6–32)	0.2
Median (range) maximum % core	40 (1–100)	40 (2–100)	40 (5–100)	30 (5–100)	0.7
Number of surgeons, n	17	15	2	6	
Mean (range) cases per surgeon, n	422 (29–4559)	328 (29–4559)	413 (106–719)	226 (48–279)	<0.001 ^{abc}

Characteristic	1991–2011 Entire cohort, n=18 319	2005–2011 RRP, n=4950	LRP, n=849	RALRP, n=1422	P
Median (range) surgeon experience, n	823 (1–4559)	1841 (1–4599)	506 (6–980)	394 (7–2862)	<0.001 abc
Surgical approach, n (%):					
open RRP	15630 (85.3)				
LRP	1263 (6.9)				
RALRP	1426 (7.8)				
RP Gleason sum, n (%):					
2–6	10703 (58.4)	2438 (49.3)	530 (62.4)	759 (53.4)	<0.001 abc
7	6348 (34.7)	2043 (41.3)	275 (32.4)	567 (39.9)	
8–10	1154 (6.3)	430 (8.7)	34 (4.0)	87 (6.1)	
Pathological stage, n (%):					
OC	12468 (68.1)	3469 (70.1)	696 (82.0)	1053 (74.1)	<0.001 abc
EPE	4748 (25.9)	1187 (24.0)	124 (14.6)	316 (22.2)	
SVI	673 (3.7)	180 (3.6)	24 (2.8)	46 (3.2)	
LNI	389 (2.1)	104 (2.1)	3 (0.4)	5 (0.4)	
PSM, n (%)	2499 (13.6)	651 (13.2)	152 (17.9)	258 (18.1)	<0.001 ab
pT2 PSM	587 (4.7)	141 (4.1)	76 (10.9)	88 (8.4)	<0.001 ab

P-values define comparison of RRP, LRP and RALRP trend from 2005–2011. Significant pair-wise comparisons are denoted as follows: (a) RRP vs LRP, (b) RRP vs RALRP and (c) LRP vs RALRP. EPE, extraprostatic extension; LNI, lymph node involvement; OC, organ-confined; PSM, positive surgical margin; SVI, seminal vesicle invasion.

Table 2

Primary reason for delay in discharge and overall complication rate for 'off-pathway' patients 2005–2011

Primary delay/complication	Entire cohort, n=7126, n (%)	RRP, n=4950, n (%)	LRP, n=849, n (%)	RALRP, n=1422, n (%)	P
<u>RP-specific complications</u>					
Anaemia/transfusion	9 (0.126)	4 (0.081)		5 (0.353)	0.01
Bleeding, re-exploration	6 (0.084)	3 (0.061)		3 (0.212)	0.1
Haematuria	4 (0.056)	4 (0.081)			0.28
Urine leak, non-operative	6 (0.084)	4 (0.081)		2 (0.141)	0.5
Urine leak, operative	6 (0.084)	2 (0.041)		4 (0.283)	0.009
Atrial fibrillation with RVR	3 (0.042)	1 (0.020)	1 (0.123)	1 (0.071)	0.3
AKI (rising creatinine)	4 (0.056)	1 (0.020)	1 (0.123)	2 (0.141)	0.07
Bowel injury/repair or fistula	3 (0.042)	2 (0.041)		1 (0.071)	0.6
DVT	3 (0.042)	2 (0.041)	1 (0.123)		0.4
Fever/atelectasis	3 (0.042)	2 (0.041)		1 (0.071)	0.6
Ileus	44 (0.615)	14 (0.284)	3 (0.369)	27 (1.908)	<0.001
Myocardial infarction	3 (0.042)	1 (0.020)	1 (0.123)	1 (0.071)	0.3
Pain	2 (0.028)	1 (0.020)	1 (0.123)		0.14
Pneumonia	4 (0.056)	1 (0.020)	1 (0.123)	2 (0.141)	0.07
Pulmonary embolus	3 (0.042)	3 (0.061)			0.4
Respiratory compromise	2 (0.028)	1 (0.020)		1 (0.071)	0.3
SBO, operative	2 (0.028)	1 (0.020)		1 (0.071)	0.3
Sepsis	0				
Spinal headache	2 (0.028)	2 (0.041)			0.4
Tachycardia	1 (0.014)	1 (0.020)			0.6
<u>Non-surgical delay in discharge</u>					
Alcohol withdrawal	2 (0.028)	2 (0.041)			0.4
Anticoagulation or bleeding diathesis, unrelated to RP	3 (0.042)	1 (0.020)		2 (0.141)	0.07
Aseptic knee effusion	1 (0.014)			1 (0.071)	0.06
<i>Clostridium difficile</i> infection	1 (0.014)	1 (0.020)			0.6
No specified cause	9 (0.126)	6 (0.122)		3 (0.212)	0.01

	Entire cohort, n=7126, n (%)	RRP, n=4950, n (%)	LRP, n=849, n (%)	RALRP, n=1422, n (%)	P
Total	126 (1.762)	60 (1.212)	9 (1.060)	57 (4.008)	
Total complications					
<u>RP-specific complications</u>					
Anaemia/transfusion	18 (0.252)	10 (0.203)		8 (0.565)	0.02
Bleeding, re-exploration	6 (0.084)	3 (0.061)		3 (0.212)	0.1
Haematuria	5 (0.070)	5 (0.102)			0.28
Urine leak, non-operative	13 (0.182)	5 (0.102)		8 (0.565)	0.007
Urine leak, operative	6 (0.084)	2 (0.041)		4 (0.283)	0.009
<u>General surgical or anaesthesia-related complications</u>					
Atrial fibrillation with RVR	3 (0.042)	1 (0.020)	1 (0.123)	1 (0.071)	0.3
AKI (rising creatinine)	6 (0.084)	3 (0.061)	1 (0.123)	2 (0.141)	0.34
Bowel injury/repair or fistula	3 (0.042)	2 (0.041)		1 (0.071)	0.6
DVT	4 (0.056)	2 (0.041)	2 (0.246)		0.06
Fever/atelectasis	4 (0.056)	3 (0.061)		1 (0.071)	0.6
Ileus	45 (0.629)	14 (0.284)	4 (0.493)	27 (1.908)	<0.001
Myocardial infarction	3 (0.042)	1 (0.020)	1 (0.123)	1 (0.071)	0.3
Pain	2 (0.028)	1 (0.020)	1 (0.123)		0.6
Pneumonia	5 (0.070)	2 (0.041)	1 (0.123)	2 (0.141)	0.2
Pulmonary embolus	3 (0.042)	3 (0.061)			0.4
Respiratory compromise	4 (0.056)	2 (0.041)	1 (0.123)	1 (0.071)	0.6
SBO, operative	2 (0.028)	1 (0.020)		1 (0.071)	0.3
Sepsis	1 (0.014)	1 (0.020)			0.6
Spinal headache	2 (0.028)	2 (0.041)			0.4
Tachycardia	1 (0.014)	1 (0.020)			0.6
<u>Non-surgical delay in discharge</u>					
Alcohol withdrawal	2 (0.028)	2 (0.041)			0.4
Anticoagulation or bleeding diathesis, unrelated to RP	3 (0.042)	1 (0.020)		2 (0.141)	0.07
Aseptic knee effusion	1 (0.014)			1 (0.071)	0.06
<i>Clostridium difficile</i> infection	1 (0.014)	1 (0.020)			0.6
No specified cause	9 (0.126)	6 (0.122)		3 (0.212)	0.01
Total	152 (2.126)	74 (1.495)	12 (1.413)	66 (4.641)	

AKI, acute kidney injury; RKR, rapid ventricular response; SBO, small bowel obstruction.

Table 3

Patient and prostate cancer characteristics for men 'on-pathway' and 'off-pathway' from 2005–2011

Characteristic	'On-pathway' – LOS 1–3 days, n=6988	'Off-pathway' – LOS 4–21 days, n=126	P
Median (range) age, years	59 (34–81)	60 (36–74)	0.2
Family history, n (%)	2669 (38.2)	46 (36.5)	0.7
Median (range) BMI, kg/m ²	27.1(14.9–56.3)	27.8(19.4–41.7)	0.6
Race, n (%):			0.008
African-American	782 (11.2)	26 (20.6)	
Asian	81 (1.2)	2 (1.6)	
Caucasian	5783 (82.8)	88 (69.8)	
Other	342 (4.9)	10 (7.9)	
CCIScore, n (%):			0.6
0	2074 (82.6)	45 (78.9)	
1	367 (14.6)	10 (17.5)	
2	56 (2.2)	1 (1.8)	
3	12 (0.5)	1 (1.8)	
Clinical stage, n (%):			0.2
cT1	5251 (75.1)	96 (76.2)	
cT2a	1078 (15.4)	18 (14.3)	
cT2b	376 (5.4)	4 (3.2)	
cT2c or cT3	77 (1.1)	3 (2.4)	
Median (range) PSA level, ng/mL	4.9 (0.1–97.2)	5.0 (0.7–49.9)	0.1
Biopsy Gleason sum, n (%):			0.1
2–6	4446 (63.6)	88 (69.8)	
7	218 (3.1)	28 (22.2)	
8–10	409 (5.9)	10 (7.9)	
Median (range) positive cores, n	3.18(1–16)	3.17(1–11)	0.7
Median (range) total cores, n	12 (1–99)	12 (10–22)	0.7
Median (range) max percentage core, n	40 (2–100)	30 (5–100)	0.3
Number of surgeons	15		
Mean (range) cases per surgeon	465 (29–973)	8.4 (0–22)	
Median (range) surgeon experience, n	1237 (1–4599)	534 (14–4450)	
Surgical approach, n (%):			<0.001
open RRP	4836 (69.2)	61 (48.4)	
LRP	801 (11.5)	9 (7.1)	
RALRP	1350 (19.3)	56 (44.4)	
RP Gleason sum, n (%):			0.8
2–6	3604 (51.6)	66 (52.4)	
7	2794 (40.0)	47 (37.3)	
8–10	536 (7.7)	11 (8.7)	
Pathological stage, n (%):			0.04
OC	5035 (72.1)	101 (80.2)	

Characteristic	'On-pathway' – LOS 1–3 days, n=6988	'Off-pathway' – LOS 4–21 days, n=126	P
EPE	1588 (22.7)	20 (15.9)	
SVI	244 (3.5)	1 (0.8)	
LNI	108 (1.5)	4 (3.2)	
PSM	1021 (14.6)	18 (14.3)	0.9
pT2 PSM	288 (5.7)	8 (7.9)	0.4

EPE, extraprostatic extension; LNI, lymph node involvement; OC, organ-confined; PSM, positive surgical margin; SVI, seminal vesicle invasion..

Table 4

Multivariable logistic regression predicting 'off-pathway' discharge

Variable	Hazard ratio (95% CI)	P
Age	1.03(1.00–1.1)	0.048
Race (Caucasian ref.)		
African-American	1.92(1.23–3.0)	0.004
Asian	2.01(0.62–6.5)	0.246
Other	1.88(0.97–3.7)	0.063
Surgical experience (per 100 cases)	0.98(0.96–0.999)	0.02
Approach (RRP ref.)		
LRP	0.65(0.32–1.3)	0.237
RALRP	2.23(1.45–3.4)	<0.001