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ORIGINAL ARTICLE

Next-day discharge after minimally invasive partial nephrectomy: an analysis of the US National Surgical Quality Improvement Program

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Abstract

Purpose Clinical care pathways and new technologies have decreased the length of stay after many surgeries. However, doubt exists about the safety of shorter hospital stays. We sought to evaluate the feasibility of next-day discharge after minimally invasive partial nephrectomy in a national cohort of US patients and surgeons.

Methods Using the National Surgical Quality Improvement Program database, we analyzed patients who underwent minimally invasive partial nephrectomy from 2012 to 2016. Patients were grouped into discharge on post-operative day 1, or discharge on days 2 and 3. Propensity score matching was used to balance patient characteristics and univariable analysis was used to determine the effect of next-day discharge on readmission, post-discharge complications, and major post-discharge complications.

Results A total of 8153 patients were included in the analysis and 4430 were matched. The matched cohort was balanced on all patient and peri-operative characteristics. On univariable analysis, no increase in odds were observed in the next-day discharge group for readmission (odds ratio 0.8; 95% confidence interval 0.6–1.4; $p=0.2$), post-discharge complications (odds ratio 1.0; 95% confidence interval 0.7–1.4; $p=0.9$), or post-discharge major complications (odds ratio 0.9; 95% confidence interval 0.5–1.4; $p=0.6$).

Conclusions Next-day discharge in select patients after minimally invasive partial nephrectomy is effectively being utilized by a large, nationwide cohort of surgeons. This approach is feasible in certain patient populations though further research must determine selection criteria for safe next-day discharge.

Keywords Nephrectomy · Quality improvement · Minimally invasive surgical procedures · Patient readmission · Postoperative complications

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Introduction

Throughout the last decade, value based care has become increasingly important [1]. Elective surgery, with its ability to dictate patient selection and peri-operative pathways, is in a unique position to provide cost-effective, high quality care. New technologies and the standardization of post-operative pathways have decreased length of stay (LOS) across many surgical sub-specialties [2–4]. Reducing LOS may decrease costs; however, it is imperative to avoid adverse events as even a single complication may double the cost of surgery [5]. In this regard, there exists hesitation that decreasing LOS may impact post-operative outcomes [6, 7].

The use of partial nephrectomy to treat renal masses has increased over the last two decades [8–10]. Meanwhile, the adoption of laparoscopic and robotic techniques has dramatically decreased the LOS in these patients compared to those undergoing open partial nephrectomy [11, 12]. During this time period, other surgical procedures have undergone shifts from multi-day hospitalizations to discharge on post-operative day (POD) 1 [13, 14]. The possibility of next-day discharge (NDD) has been explored in partial nephrectomy; however, the current studies represent institutional experiences and limited number of patients [15, 16]. While these results are promising, they are difficult to generalize. Therefore, we sought to evaluate the use of NDD in patients undergoing minimally invasive partial nephrectomy (MIPN) using the American college of surgeons national surgical quality improvement program (ACS NSQIP), a large, validated database of surgical procedures and outcomes.

Materials and methods

Patients undergoing MIPN from 2012 to 2016 were identified through the ACS NSQIP participant use file. ACS NSQIP is a collection of data that are submitted by individual hospitals on their inpatient and outpatient procedures. Data are aggregated and do not allow identification of individual patients, surgeons, or hospitals. It includes demographics, peri-operative variables, as well as outcomes tracked for 30 days from the day of surgery. The 2016 file contains over a million cases from 680 submitting sites [17]. This study was not considered human subjects research by the University of Pennsylvania Institutional Review Board due to the de-identified nature of NSQIP and thus was not required to undergo review.

All patients with a Common Procedural Terminology (CPT) code for MIPN (CPT 50543) were initially included in our analysis ($n = 11{,}262$). Patients were excluded if they were transferred to the hospital of their operation ($n = 58$), underwent emergent or non-elective procedures ($n = 204$), or were hospitalized prior to their operation ($n = 60$). Patients with disseminated cancer ($n = 128$), who died during their hospital stay ($n = 7$), and who had key missing variables were also excluded ($n = 727$). Finally, to generalize our results to patients with a typical post-operative course, patients with a LOS of 0 days or greater than 3 days were excluded (n = 1925). Cohort selection is shown in online resource Figure A1.

Patient covariates included age, sex, race, body mass index (BMI), comorbidity score, smoking status, discharge location, operative time, and the presence of a pre-discharge complication. Race included white, African American, and other/unknown. BMI was separated into underweight (BMI < 18.5 kg/m^2), normal weight (BMI 18.5–24.9 kg/m^2), overweight (BMI 25–29.9 kg/m^2) and obese (BMI ≥ 30 kg/m^2). Comorbidity score was generated by summation of medical comorbidities consistently collected by NSQIP into categories of 0–2, and ≥ 3.

Patients were stratified into NDD and standard discharge (SD) groups. NDD was defined as patients with a LOS of 1 day, while those with a LOS of 2–3 days were grouped as SD. These groups were chosen based on clinical judgment to represent typical post-operative courses after uncomplicated MIPN. Univariable and multivariable logistic regression were used to determine the effect of all patient covariates on NDD. Propensity scores matched patients between the NDD and SD groups using 1:1 nearest neighbor matching with a caliber size of 0.1 and without replacement. Scores were calculated using logistic regression for patient covariates associated ($p < 0.1$) with NDD on univariable analysis.

Propensity scores allow for matching based on known confounders and attempts to counter selection bias in observational studies. Regression is used to create a propensity score for each patient that indicates their likelihood to receive treatment, early discharge in this case, based on the covariates. Patients are then matched to patients in the other treatment group in a 1:1 greedy fashion based on these scores. Standardized differences were used to test the balance between groups before and after matching, with values < 0.1 indicating balance.

Outcomes of this study were 30-day post-surgical readmission, any post-discharge complication, and post-discharge major complications. Complications included superficial surgical site infection (SSI), deep SSI, organ space SSI, wound dehiscence, pneumonia, reintubation, ventilator support for > 48 h, acute renal failure, renal insufficiency, urinary tract infection (UTI), cerebrovascular accident, cardiac arrest, myocardial infarction, post-operative transfusion < 72 h after surgery, sepsis, septic shock, deep venous thrombosis, pulmonary embolism, reoperation, and death. As reported in our previous paper, major complications included all complications except superficial and deep SSI, wound dehiscence, renal insufficiency, UTI, and post-operative transfusion [18].

Descriptive statistics for the patient cohort and outcomes were analyzed both overall and stratified by NDD and SD. Comparisons between the LOS groups were analyzed using Chi-square tests and two-sided t-tests. After matching, univariable logistic regression was used to determine the association between NDD and readmission, any post-discharge complication, and post-discharge major complications. All statistical analysis used two-sided tests with an α of 0.05, and was done using STATA 13 (StataCorp LP, College Station, TX, USA).

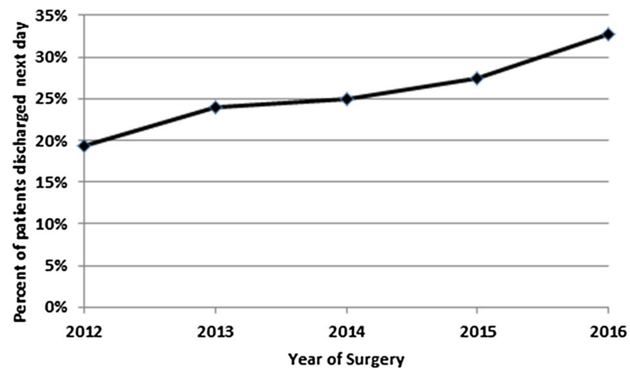

Fig. 1 Percent of discharges that were NDD between 2012 and 2016

Results

Patient demographics

We identified 8153 patients undergoing MIPN. The NDD group had 2216 (27.2%) patients and 5937 (72.8%) were in the SD group. Patient and operative characteristics stratified by NDD and SD are shown in online resource Table A1. Males ($p = 0.003$) were more likely to be discharged the day after surgery. Diabetes ($p = 0.002$), dyspnea ($p = 0.002$), and bleeding disorders ($p = 0.002$) were more common in the SD group (online resource Table A2). Patients discharged the next day were observed to have fewer rates of pre-discharge complications (0.5 versus 2.5%; $p < 0.001$), and similar rates of both post-discharge complications (3.0 versus 3.3%; $p = 0.9$) and unplanned readmissions within 30 days of surgery (3.0 versus 4.2%; $p = 0.08$). Outcomes before and after matching are shown in Table 1. The number and category of complications before and after discharge are shown in online resource Tables A3. Figure 1 shows the proportion of NDD discharge patients, which increased every year, starting from 19.4% in 2012, and ending at 32.8% in 2016.

Factors predicting next-day discharge

Online resource Table A4 shows the factors analyzed for their effect on NDD using both univariable and multivariable analysis. On multivariable analysis prior to matching, older age [Odds ratio (OR) 1.0; 95% confidence interval (95% CI) 1.0–1.0; $p = 0.003$], female sex (OR 0.8; 95% CI 0.7–0.9; $p < 0.001$), other/unknown race (OR 0.6; 95% CI 0.5–0.7; $p < 0.001$), a comorbidity score of ≥ 3 (OR 0.7; 95% CI 0.5–0.9; $p = 0.01$), an increased operative time ($p < 0.001$ for all categories), discharge to continued care (OR 0.4; 95% CI 0.2–0.9; $p = 0.04$), and any pre-discharge complication (OR 0.2; 95% CI 0.1–0.5; $p < 0.001$) were associated with decreased odds of NDD. African American race (OR 1.3; 95% CI 1.1–1.5; $p = 0.007$) and an increased hematocrit (OR 1.0; 95% CI 1.0–1.0; $p = 0.04$) were associated with an increased likelihood of NDD.

Analysis for outcomes after matching

After propensity score matching, 4430 patients remained. Online resource Table A1 shows characteristics of the matched cohort along with standardized differences which indicated that all variables were balanced after matching. No association was observed between NDD and readmission (OR 0.8; 95% CI 0.6–1.1; $p = 0.2$), post-discharge

Table 1 Post-discharge outcomes by discharge group before and after matching. Odds ratios for NDD's effect on outcomes are displayed from the unmatched multivariate analysis and the matched univariate analysis

Unmatched cohort	Next-day discharge *n* (%)	Standard discharge *n* (%)	*p*	Odds ratio [95% confidence interval]	*p*
Readmission	67 (3.0)	248 (4.2)	0.02	0.8 [0.6–1.0]	0.07
Post-discharge complication	67 (3.0)	198 (3.3)	0.5	1.0 [0.7–1.3]	0.9
Post-discharge major complication	34 (1.5)	116 (2.0)	0.2	0.8 [0.6–1.2]	0.3
Matched cohort					
Readmission	67 (3.0)	82 (3.7)	0.2	0.8 [0.6–1.1]	0.2
Post-discharge complication	67 (3.0)	69 (3.1)	0.9	1.0 [0.7–1.4]	0.9
Post-discharge major complication	34 (1.5)	39 (1.8)	0.6	0.9 [0.5–1.4]	0.6

complications (OR 1.0; 95% CI 0.7–1.4; $p = 0.9$), or major post-discharge complications (OR 0.9; 95% CI 0.5–1.4; $p = 0.6$).

Discussion

Using a large US surgical database, we found that a heterogeneous group of surgeons were able to select patients for NDD after partial nephrectomy without an increased risk of readmission or complications. To the knowledge of the authors, this is the first study to confirm this finding for both readmission and complications using a national cohort. The results of the analysis provide observational data and proof of concept that NDD is feasible in approximately 25% of cases. However, due to the observational nature of the study and uncontrollable residual biases, a risk factor analysis that distinguishes between NDD and SD candidates was not possible.

NDD has been explored and deemed safe in other surgeries. Using NSQIP, Elnahas et al. [18] studied 7967 patients undergoing laparoscopic sleeve gastrectomy and found that NDD led to a reduction in adverse events at 30 days. NDD has been shown to be safe for cesarean section, and can be accomplished by standardizing post-operative pathways [19]. In urology, Khemees et al. [20] demonstrated a successful pathway for NDD in patients undergoing robotic nephroureterectomy. In our study, we were unable to account for confounding factors such as tumor characteristics that would allow us to directly draw conclusions about the safety of NDD. However, we found that our readmission rates for the NDD group were similar or lower than those previously reported for patients undergoing partial nephrectomy for T1a tumors [21]. From 2012 to 2016, the proportion of NDD patients also increased. This is likely the result of increased adoption of robotic approaches, which may decrease LOS compared to laparoscopic approaches [12, 22]. Our study demonstrates that NDD may be considered by surgeons performing MIPN on healthy, non-complex patients, and its indication may be expanded after further evaluation of selection criteria.

Standardization of peri-operative protocols, such as "enhanced recovery after surgery," have shown success at reducing LOS in a variety of surgical subspecialties, including radical cystectomy [4, 23, 24]. Single institution experiences with NDD after MIPN have been reported using these strategies. Patel et al. [15] developed a care pathway consisting of non-steroidal anti-inflammatory agents for pain and ambulation on POD 0. Out of 263 patients, 157 (60%) were discharged on POD 1, and readmission within the early discharge group was not higher than the standard discharge group. Abaza and Shah [16] prospectively collected data on 150 patients who underwent robotic partial nephrectomy and found that 97% of their 150 patients were able to be discharged on POD 1. While they did not compare their results to a control group, 4 (3%) of their patients were readmitted, which is similar to our readmission rate. An even more aggressive approach was proposed by Bernhard et al. [25] who evaluated the feasibility of outpatient MIPN in a single patient. However, larger-scale studies are needed to determine if this approach is safe.

Factors affecting LOS and readmission risk have been studied in MIPN. In particular, a retroperitoneal compared to transperitoneal approach, has been shown to result in a shorter LOS and lower complication rate [26, 27]. Maurice et al. [28] analyzed variables that led to a LOS > 3 days or readmission, and found that factors such as black race and tumor characteristics predicted both of these outcomes. While NSQIP does not collect information about tumor stage, we found that an increased operative time decreased the odds of NDD. This may indicate that NDD patients underwent less complex surgeries, or were operated on by surgeons who take longer, whether that is due to experience or normal practice. Additionally, NDD patients had lower rates of post-operative transfusion, which may indicate that a concern for hemorrhage contributed to patients in the SD group. Using a five-center database for robotic partial nephrectomy, Larson et al. [29] found that patients with a prolonged LOS had a higher nephrometry score and post-operative transfusion predicted a LOS > 4 days.

We would stress that there are multiple unmeasured confounders that are not collected by the NSQIP database and cannot be accounted for by any statistical methodology. The lack of important covariates, such as tumor characteristics, hospital volume, teaching hospital status, and surgeon experience, limits the generalizability of the results of the current analysis. It is more likely that MIPNs with NDD were performed in teaching hospitals or in higher-volume hospitals, as well as in patients with small, and non-complex masses. These observations may explain the reported differences between the NDD and SD groups. Prospective studies that collect a wider range of variables are needed to predict which patients should be discharged the day after surgery. However, the results of our study show that a heterogeneous group of surgeons and patients are effectively using this approach. Its application is feasible outside the highly controlled single institution studies that are currently present in the literature.

Our study has several limitations. Importantly, NDD following MIPN is likely the product of careful patient selection, engagement, and clinical care pathways. Our study is subject to selection bias, and this is highlighted by the differences between the NDD and SD groups. We attempted to control for this with propensity score matching. However, there are a number of unmeasured confounders that might affect our results, such as the time of day when the surgery finished and post-operative pain control. Patients discharged on POD 1 likely had surgeries for small, exophytic masses compared to those discharged on POD 2 or POD 3, which may have had larger masses and more complicated surgeries. Unfortunately, NSQIP does not collect tumor characteristics or RENAL nephrometry score, and this lack of data on tumor size represents a major limitation and source of uncontrolled bias that likely favored NDD in patients with smaller renal masses. While NSQIP represents data from hundreds of hospitals, it is de-identified and thus unclear how many MIPN each hospital or surgeon contributed to this data. Differing experience among surgeons and volume among hospitals may affect intraoperative variables such as operative time or complications as well as post-operative decision-making such as selecting patients for NDD. If most of the cohort's surgeries were performed by a small number of surgeons, it may limit the generalizability of our conclusions. NSQIP collects data on comorbidities and complications in a binary fashion, and thus we were not able to calculate a Charlson comorbidity index or Clavien Dindo grade. While only MIPN was included in our study, we were unable to differentiate between patients who underwent laparoscopic versus robotic nephrectomy because they are coded with the same CPT. Finally, differences may exist between hospitals that report their data to NSQIP and those that do not; so our results may not be universally generalizable. Critical to the interpretation of our results, we would not recommend this approach for every patient undergoing MIPN. Rather, we would conclude that a large cohort of surgeons are effectively selecting these patients, and further work might delineate selection criteria to mirror their results.

Conclusions

NDD following MIPN has been applied to a heterogeneous group of patients without adverse results. This approach is feasible; however, patient selection and care pathways that standardize operative courses must be further defined. Safely reducing LOS may decrease resource utilization.

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Compliance with ethical standards

Conflict of interest No competing financial interests exist for any author.

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