

Research Article

Universally Applied Precautionary Measures to Prevent Hypertension in a Partial Nephrectomy Clinical Care Pathway Reduces Incidence of Post Operative Hemorrhage

David Sikule, Tracey Ho, John Perrotti, Julianne Wilkinson, Alan Perrotti, James Cavalcante, Leigh Python, Gerald Wilkinson, and Michael Perrotti*

Department of Surgery, St Peter's Hospital, USA

***Corresponding author**

Michael Perrotti, Department of Surgery, St Peter's Hospital, St. Peter's Mercy Care Campus, 319 S. Manning Blvd, Suite 308A, Albany, New York 12208, USA, Tel: 518-438-5300; Fax: 518-438-5301; Email: perrotmi@yahoo.com

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Abstract

Purpose: Clinical care pathways have been shown to reduce hospital length of stay without increasing post operative adverse events. In the present study, we sought to determine whether universally applied precautionary measures to prevent peri-operative hypertension (HTN) into an established standardized care pathway may reduce acute post operative hemorrhage (APOH) following partial nephrectomy.

Methods: We retrospectively reviewed a database comprised of patients undergoing partial nephrectomy at our institution by the same surgical team. Starting in January of 2013, all patients undergoing partial nephrectomy received screening for and universally applied aggressive management of HTN and its prevention in the peri-operative period. The APOH rate was calculated for the study cohort (Group 1, n=52) and compared to the control group (Group 2, n=200) managed immediately preceding implementation of HTN universal precautions. Clinico-pathologic factors assessed for their relationship to APOH were patient age, gender, diabetes, smoking, hypertension, coronary artery disease, American Society of Anesthesia Score (ASA), tumor size, pathologic result, cancer margin status, operative time and estimated intra-operative blood loss.

Results: Data were analyzed from 252 consecutive patients. In Group 1 (n=200), 7 patients (3.5%) experienced APOH. In that cohort, risk factors for APOH were male gender and hypertension. The impact of APOH on subsequent hospital course, ancillary procedures and renal loss are reported. In Group 2 (n=52) hypertensive precautions were universally applied. In this cohort, there were no episodes of APOH, and no required ancillary procedures.

Conclusion: Our preliminary results at the time of this early interim analysis appear to indicate that hypertensive universal precautions in a previously established partial nephrectomy clinical care pathway reduced the incidence of acute post operative hemorrhage. Reduction of APOH reduced additional adverse post operative sequelae and improved renal preservation.

INTRODUCTION

Clinical care pathways have been shown to reduce hospital length of stay without increasing post operative adverse events. The accountable care environment has continued to emphasize the importance of improving outcomes while reducing cost and resource allocation. Thus far, CMS quality measures have been broadly applied across multiple specialties and include documentation of health care proxy, vaccination status, obtainment of vitals and medicine reconciliation. The goal of such measures is multifold, but includes an effort to standardize clinical practice. Development of specialty specific quality

measures are in evolution. At the 2017 Annual Meeting of the American Urologic Association, it was agreed that specialists and their respective societies are best positioned to develop not only guidelines, but clinical care pathways and measures of quality as they relate to outcomes. Ideally, development of effective clinical care pathways should reduce variability in clinical practice and improve patient outcomes. Improved patient outcomes have been and remain at the core of clinical investigative science.

Hemorrhage following partial nephrectomy is a rare but potentially devastating complication. Jung and colleagues recently reported a post operative hemorrhage rate severe enough

to require invasive intervention in 13 (4.3%) of 300 patients studied. An additional 14 (4.6%) of 300 patients experienced hemorrhage that did not require invasive intervention [1]. In that study, the radiographic tumor exophyticity score was the only significant predictor of post operative hemorrhage. Cavalcante and colleagues reported post operative hemorrhage in 7 (3.5%) of 200 consecutive patients undergoing partial nephrectomy [2]. Post operative hemorrhage was defined as an acute drop in hematocrit (<8mg/dl) and radiographic evidence of either peri-nephric retroperitoneal hematoma or blood within the renal collecting system of the operated kidney regardless of requirement for invasive intervention. In that study, patient factors statistically associated with acute post operative hemorrhage were male gender and hypertension. In that study, post operative hemorrhage was associated with extended post operative hospital stay (median, 5 days; range 2-11 days), increased transfusion requirement (median, 6 units; range, 1-16), need for ancillary procedures (median, 2) and increased risk of loss of the operated kidney (n=2).

In the present study, we sought to determine whether implementation of universally applied precautionary measures to prevent peri-operative hypertension (HTN) into an established standardized care pathway may reduce acute post operative hemorrhage (APOH) following partial nephrectomy. Investigators have clearly recognized the risks associated with allogenic blood transfusion [3], and have reported on efforts to reduce both surgical bleeding and transfusion [4,5] and the role of intra-operative blood pressure management [6]. We build on these concepts further and address the potential role universal precautions to prevent post-operative hypertension in patients undergoing partial nephrectomy.

METHODS

Database

We retrospectively reviewed a database comprised of patients undergoing partial nephrectomy at our institution by the same surgical team. Beginning in January of 2013, all patients undergoing partial nephrectomy received screening in the clinic for hypertension and documentation in the electronic medical record (EMR). High blood pressure was defined as a pressure of 140 systolic or higher and/or 90 diastolic or higher. A flag was developed in our EMR system to identify those patients with both renal mass and hypertension listed under medical history. All patients with HTN and renal mass were referred to our cardiology service pre operatively for assessment and management.

Clinical care pathway

Our clinical care pathway (Table 1) has been described previously [7]. In brief, patients and family members receive counseling pre-operatively regarding medication review, preparation for surgery and discussion about anticipated hospital course. Patients take clear liquids and mechanical bowel prep on the day prior to surgery. Patients receive acetaminophen immediately pre-operatively and as a standing order 650 mg per oral every 6 hours. Patients are transitioned to oral pain medications on the first post operative night. The target date for discharge is the 3rd post operative day. In the present study cohort,

Table 1: Partial nephrectomy clinical care pathway.

| Day | Goal |
|--|---|
| Preoperative | Patient and family counseling Medication review HTN screening / EMR flag / referral to cardiology Preparation instructions |
| Postoperative day 0 | Start metoprolol 5mg iv in PACU and q 6hrs Maintain MAP of ≤ 80 Clear liquids Acetaminophen 650mg po q 6hrs Oral pain meds OOB at least once |
| Postoperative day 1 | OOB four times Liquid diet discontinue parenteral narcotics |
| Postoperative day 2 | Remove foley catheter at 0700hrs OOB ad lib Regular diet Assess for possible discharge |
| Postoperative day 3 | Discharge |
| HTN=hypertension; EMR=electronic medical record; PACU=post anesthesia care unit; MAP=mean arterial pressure; po=per oral; OOB=out of bed | |

all patients received metoprolol as 5mg iv in the recovery room and then every 6 hrs as a standing order with hold parameters for systolic blood pressure below 110mmHg or heart rate less than 50 bpm. Cardiology assisted with additional antihypertensive agents as needed to maintain the mean arterial pressure below 80 during the postoperative period.

Statistical analysis

The APOH rate was calculated for the study cohort (group 1) and compared to the control group (group 2) managed immediately preceding implementation of HTN universal precautions. Univariate statistical analysis was performed using the Chi-square analysis and Fisher's exact test as appropriate for categorical data [8]. These included gender, hypertension, smoking, diabetes, coronary artery disease, American Society of Anesthesiology (ASA) Score (dichotomized as 1 and 2 versus 3, 4 and 5), tumor laterality, pathologic result (cancer versus benign), surgical margin status (cancer at margin versus not). The Mann-Whitney test [8] was utilized for continuous data including age, tumor size, R.E.N.A.L. nephrotomy score, operative time, renal artery clamp time and intra-operative blood loss. The paired T test was used to statistically assess the difference in pre-operative and post-operative serum hemoglobin levels in the study cohort.

Surgical technique

The retroperitoneal flank approach was used in all cases. All surgery cases were performed under general anesthesia. Blood pressure was maintained as normotensive by the anesthesia team. The kidney was explored and vessel loop passed to tag the ureter, renal artery (s) and renal vein (s). A double loop was passed around the vein (s) for subsequent occlusion. The renal artery was clamp in all cases and the kidney cooled. The renal vein was selectively occluded as required to provide a bloodless operative field. The tumor mass was excised with the cautery

on a coagulation setting of 60. The collecting system was closed with 3-0 monocryl suture on SH needle in running fashion. Renal vessels were oversewn in figure of eight fashion with 3-0 monocryl on SH needle. Prior to the removal of the renal artery clamp, the kidney was reconstructed essentially obliterating the resection defect utilizing 0-chromic suture on CT needle in horizontal mattress fashion. This resulted in reniform shape approximation in nearly all cases. The kidney was then placed back in its anatomic position and all clamps and vessel loops removed.

RESULTS

Data were analyzed from 252 consecutive patients. Table 2 presents the clinical features of the cohort managed with universally applied precautionary measures to prevent peri-operative hypertension. Seventeen (32.6%) of patients were found to have hypertension pre-operatively and were flagged accordingly in our electronic medical record system. This triggered cardiology referral. All patients received metoprolol as 5mg intra-venously in the PACU, and then as 5mg iv q 6hour as a standing order with hold parameters. Nine (17%) of patients required cardiology consultation postoperatively for hypertention management to maintain a mean arterial pressure < 80Hg. Four (44%) of the patients requiring hypertension management by cardiology post-operatively had not been found to have hypertension in the pre-operative period, and all of these patients were male. None developed mean arterial pressures above 90mmHg during their hospital stay. Among patients treated prior to universally applied precautionary measures to prevent peri-operative hypertension (group 1, n=200), 7 patients (3.5%) experienced APOH. In that cohort, risk factors for APOH were male gender (p=0.03) and hypertension (p=0.006). APOH resulted in an increased LOS (median, 5 days), increased transfusion requirement (median, 6 units), and increased risk of renal loss (n=2). All patients in the study cohort (group 2, n=52) were managed according to our standardized clinical care pathway with universally applied precautionary measures to prevent peri-operative hypertension. In this cohort (Table 3), no patient experienced APOH. This difference approached but did not reach statistical significance (Fisher exact probability test, p=0.1). One patient in the study cohort received blood transfusion (1 unit PRBC). There was a statistically significant (p=0.006, Paired T test) difference in pre and post surgical hemoglobin levels in the study cohort. This difference was not clinically significant. The discharge median hemoglobin level in the study cohort was 12.3g/dl, range 8.7 - 16.6 (Table 3). No patient required subsequent surgical intervention. There were 2 post discharge readmissions to the hospital. One patient was admitted for management of constipation. One patient was admitted for management of congestive heart failure. An additional patient had a superficial wound infection managed as an outpatient.

DISCUSSION

Kidney cancer incidence continues to rise in the United States [9], and the majority of cases (> 60%) are small renal masses that are less than 4 cm in greatest diameter [10]. The most recent American Urological Association guidelines recommend partial nephrectomy as the first-line therapy for all T1a cancers, and

Table 2: Clinical features of patients undergoing partial nephrectomy.

| | |
|--|-----------------|
| Pt No. | 52 |
| Age (years) | 57 (32 - 77) |
| Tumor size (cm) | 3.4 (2 - 7) |
| Hgb (g/dl) | 13.4 (9 - 16.7) |
| Male | 32 (62%) |
| Female | 20 (38%) |
| Tumor side | |
| Left | 23 (44%) |
| Right | 29 (56%) |
| Hypertension | 17 (32%) |
| Diabetes | 14 (26%) |
| Smoking | 16 (31%) |
| CAD | 7 (13%) |
| ASA | 2 (2-3) |
| Pt. No.=patient number; Hgb=hemoglobin; age, Hgb and tumor size are expressed as the median and range; cm=centimeters; CAD=coronary artery disease; ASA=American Society of Anesthesiology | |

Table 3: Surgical outcome and hospital course of patients undergoing partial nephrectomy.

| | |
|---|-------------------|
| Pt. No. | 52 |
| Pathology | |
| Malignant | 50 (96%) |
| Benign | 2 (4%) |
| Resection margin status | |
| Negative | 52 (100%) |
| Positive | - |
| Post operative Hgb (g/dl) | 12.3 (8.7 - 16.6) |
| Transfusion | 1 (1.9%) |
| No transfusion | 51 (98%) |
| APOH | |
| Yes | - |
| No | 52 (100%) |
| LOS | 3 (2 - 10) |
| Readmission | 2 (3.8%) |
| Pt. No.=patient number; APOH=acute post operative hemorrhage; Hgb=hemoglobin (expressed as median and range); LOS=length of hospital stay | |

select T1b cancers [11]. Concordant with this recommendation, partial nephrectomy utilization has increased over the past decade [12].

Hemorrhage following partial nephrectomy is a rare but potentially devastating complication. Jung and colleagues recently reported a post operative hemorrhage rate severe enough to require invasive intervention in 13 (4.3%) of 300 patients studied. An additional 14 (4.6%) of 300 patients experienced hemorrhage that did not require invasive intervention [1]. In that study, the radiographic tumor exophytic score was the only significant predictor of post operative hemorrhage.

Cavalcante and colleagues reported post operative hemorrhage in 7 (3.5%) of 200 consecutive patients undergoing partial nephrectomy [2]. Post operative hemorrhage was defined as an acute drop in hematocrit (<8mg/dl) and radiographic evidence of either peri-nephric retroperitoneal hematoma or blood within the renal collecting system of the operated kidney regardless of requirement for invasive intervention. In that study, patient factors statistically associated with acute post operative hemorrhage were male gender and hypertension.

Our current work is a continuation of the efforts outline above. We sought to determine whether implementation of universally applied precautions to prevent peri-operative hypertension (HTN) into an established standardized care pathway may reduce acute post operative hemorrhage (APOH) following partial nephrectomy. The findings of the present study appear to indicate that this approach has merit. No episodes of acute post operative hemorrhage occurred in the study cohort. The findings of this interim analysis as preliminary, however, and must be validated with increased patient accrual. The findings of this study are important for a number of reasons. A direct association between hypertension and increased risk of kidney cancer has been reported [13]. And it is, therefore, anticipated that many patients undergoing partial nephrectomy for renal cancer will experience hypertension post-operatively whether previously diagnosed and treated or previously undiagnosed as in our study. This highlights the importance of careful screening for hypertension pre-operatively in this patient cohort, and application of universally applied precautionary measures to prevent hypertension post-operatively. We developed a flag in our EMR to identify patients with both renal mass and hypertension in their medical history, given data to indicate that these patients may be at increased risk of acute post operative hemorrhage following partial nephrectomy. Investigators have identified the potential to utilize current sophisticated EMR systems to improve the care of our patients [14], far beyond achieving government mandates and quality measures. In our clinical care pathway, the RENAL MASS / HTN flag denotes increased risk of hemorrhage following partial nephrectomy. We hope that reacting to that flag (precautionary measures to prevent peri-operative hypertension) will reduce post operative hemorrhage in future surgical cohorts and improve outcomes in this challenging patient cohort.

CONCLUSION

Our preliminary results at the time of this early interim analysis appear to indicate that hypertensive universal precautions in a previously established partial nephrectomy clinical care pathway reduced the incidence of acute post operative hemorrhage. Reduction of APOH reduced additional adverse post operative sequelae and improved renal preservation.

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