

Beyond transfusions: bleeding-related outcomes after repeat TURP

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Abstract

Purpose

We compared perioperative morbidity after repeat transurethral resection (re-TURP) versus primary TURP, focusing on transfusion and broader bleeding-related complications relevant to counseling and risk stratification.

Methods

We analyzed the American College of Surgeons National Surgical Quality Improvement Program (2013–2023) to identify men undergoing primary TURP (Current Procedural Terminology [CPT] 52601) or re-TURP (CPT 52630). The primary outcome was 30-day red blood cell transfusion. Secondary outcomes included a prespecified postoperative hematuria endpoint based on ICD-10 codes. Multivariable logistic regression evaluated associations with bleeding endpoints and downstream complications.

Results

Among 83,539 TURP procedures, 76,983 (92.2%) were primary and 6,556 (7.8%) were repeat. Re-TURP patients were older, had higher ASA class, and more often underwent urgent surgery. Transfusion occurred in 1.9% after re-TURP versus 1.5% after primary TURP; hematuria-coded events occurred in 3.5% versus 1.3%, respectively. After adjustment, re-TURP was associated with postoperative hematuria (adjusted odds ratio [aOR] 2.42, 95% CI 2.03–2.88) but not with transfusion (aOR 1.09, 95% CI 0.87–1.36). Older age, urgent/emergent status, bleeding disorder, and lower hematocrit predicted both bleeding endpoints. Re-TURP was associated with slightly lower odds of readmission (aOR 0.87; 95% CI 0.76–0.99) and was not associated with return to the operating room. Transfusion strongly predicted return to the operating room (aOR 7.21) and readmission (aOR 2.05), whereas hematuria predicted return to the operating room only (aOR 1.50).

Conclusions

Compared with primary TURP, re-TURP was associated with more hematuria-coded events but not higher adjusted transfusion risk, suggesting a relative shift toward lower-severity bleeding morbidity.

Introduction

Lower urinary tract symptoms from benign prostatic hyperplasia (BPH) are common in older men [1]. When surgery is indicated, transurethral resection of the prostate (TURP) remains the reference treatment [2] and a benchmark against which newer alternatives are compared [3, 4]. In the United States, TURP still represents the most commonly performed procedure for BPH, accounting for about

45% of all BPH procedures [5], despite the emergence of novel techniques. Contemporary outcome assessment for TURP is therefore essential.

Although TURP is effective, approximately 7.5% of men require repeat TURP (re-TURP) within 8 years, mainly because of adenoma regrowth [6–9]. Whether re-TURP carries distinct perioperative risks relative to primary TURP remains uncertain. Population-based studies suggest higher transfusion rates after re-TURP than after primary TURP [10, 11], but comparisons were embedded within broader assessments of multiple BPH operations and relied on transfusion as the principal bleeding endpoint. Transfusion is a clinically important marker of major bleeding [12] but may undercapture lower-severity events that still affect patient well-being and resource use, such as catheter obstruction, clot retention, prolonged hospitalization, return to the operating room, or readmission [13].

To address these limitations, we compared outcomes following primary and repeat TURP in the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) database from 2013–2023, supplementing transfusion with a prespecified International Classification of Diseases, 10th Revision (ICD-10)-based postoperative hematuria endpoint. We further evaluated associations between both bleeding endpoints and return to the operating room and readmission.

Patients and Methods

Data source and cohort

We performed a retrospective cohort study using ACS NSQIP, a multi-institutional clinical registry that prospectively collects de-identified perioperative data and 30-day postoperative outcomes [14, 15]. We included adult men undergoing Current Procedural Terminology (CPT) 52601 (primary TURP) or CPT 52630 (re-TURP) from 2013 to 2023; all other cases were excluded. Because NSQIP lacks patient identifiers and captures only one principal procedure per 30-day window, procedures could not be linked longitudinally and each record was analyzed as an independent entry.

Baseline characteristics

In addition to the primary independent variable of TURP status (primary TURP vs re-TURP), preoperative and intraoperative variables were collected to control for confounding. Preoperative variables included demographics; American Society of Anesthesiologists (ASA) class; case urgency; comorbidities, including bleeding disorder and preoperative urinary tract infection (UTI); and laboratory values, including hematocrit, international normalized ratio (INR), albumin, and platelet count. Case urgency was categorized as elective, urgent/emergent, or missing. Selected intraoperative and postoperative variables included operative time (in minutes), length of stay (in days), transfusion, unplanned return to the operating room, and 30-day readmission.

Postoperative outcomes

The primary outcome was red blood cell transfusion within 30 days. Secondary outcomes included postoperative hematuria, UTI, other major complications, unplanned return to the operating room, and 30-day readmission. We compared outcomes between primary TURP and re-TURP and performed multivariable regression for transfusion, hematuria, return to the operating room, and readmission.

To identify postoperative hematuria, two reviewers prespecified and applied an ICD-10 code algorithm to the single documented postoperative diagnosis for each patient, categorizing codes as hematuria-related or non-hematuria diagnoses. The full code list is provided in Supplementary Table 1.

Statistical analysis

Continuous variables were compared with Welch's *t*-test or the Wilcoxon rank-sum test, and categorical variables with chi-squared or Fisher's exact tests. Percentages were calculated using non-missing values; denominators therefore vary by variable.

Multivariable logistic regression for transfusion and postoperative hematuria used complete-case analysis for all covariates except case urgency, for which missing values were retained as a separate category to avoid systematic exclusion and reduce potential selection bias, consistent with prior urologic registry work in which unknown clinical categories were analyzed separately [16]. Models adjusted for the following prespecified covariates: ASA class ($< IV$ or $\geq IV$), case status (elective, urgent/emergent, or missing), bleeding disorder (present or absent), preoperative UTI (present or absent), TURP status (primary TURP or re-TURP), age (per year), preoperative hematocrit (per percentage point), and operative time (per minute). Elective status was the reference category for case urgency; models included indicator terms for urgent/emergent and missing status. The multivariable models for return to the operating room and readmission additionally included transfusion and postoperative hematuria. Two-sided $p < 0.05$ was considered statistically significant. No adjustments were made for multiple comparisons. Analyses were performed in R (v4.5.1).

Results

Cohort

We identified 83,539 TURP cases in NSQIP from 2013 to 2023. These comprised 76,983 (92.2%) primary TURPs and 6,556 (7.8%) re-TURPs.

Baseline characteristics

Compared with primary TURP patients, those undergoing re-TURP were older (73.8 vs 71.3 years, $p < 0.001$), more frequently classified as ASA class III–V (60.3% vs 56.5%; $p < 0.001$), and more often had

urgent/emergent case status among cases with known urgency (9.7% vs 4.5%; $p < 0.001$) (Table 1). Bleeding disorders and hypertension were also more common in the re-TURP group (3.7% vs 3.1%, $p = 0.012$; and 63.1% vs 60.2%, $p < 0.001$, respectively).

Table 1

Preoperative characteristics of patients undergoing primary versus repeat transurethral resection of the prostate (ACS National Surgical Quality Improvement Program Database 2013–2023)

Baseline characteristics	TURP (N = 76,983)	Re-TURP (N = 6,556)	p-value
Age (years), mean (SD)	71.3 (9.4)	73.8 (9.1)	< 0.001
Caucasian race, n (%)	45,686 (59.3)	3,844 (58.6)	0.266
BMI > 30 kg/m ² , n (%)	24,455 (31.8)	2,058 (31.4)	0.264
ASA class, n (%)	—	—	< 0.001
– Class I	1,738 (2.3)	124 (1.9)	—
– Class II	31,624 (41.2)	2,466 (37.7)	—
– Class III	39,304 (51.2)	3,564 (54.5)	—
– Class IV	4,061 (5.3)	381 (5.8)	—
– Class V	12 (0.0)	2 (0.0)	—
General anesthesia, n (%)	60,929 (79.1)	5,144 (78.5)	0.204
Urgent/emergent surgery, n (%)	1,102 (4.5)	175 (9.7)	< 0.001
Bleeding disorder, n (%)	2,398 (3.1)	242 (3.7)	0.012
Diabetes, n (%)	17,558 (22.8)	1,453 (22.2)	0.238
Smoker, n (%)	8,334 (10.8)	534 (8.2)	< 0.001
Hypertension, n (%)	46,335 (60.2)	4,140 (63.1)	< 0.001
Renal failure, n (%)	299 (0.4)	32 (0.5)	0.308
Congestive heart failure, n (%)	1,734 (2.3)	143 (2.2)	0.741
Chronic obstructive pulmonary disease, n (%)	4,525 (5.9)	400 (6.1)	0.478
Preoperative urinary tract infection, n (%)	922 (1.2)	92 (1.4)	0.161
Preoperative hematocrit (%), mean (SD)	40.7 (5.4)	40.4 (5.8)	0.001
Preoperative INR, mean (SD)	1.1 (0.3)	1.1 (0.2)	< 0.001
Preoperative albumin (g/dL), mean (SD)	3.9 (0.6)	3.8 (0.6)	0.005
Abbreviations: ACS = American College of Surgeons; TURP = transurethral resection of the prostate; re-TURP = repeat transurethral resection of the prostate; SD = standard deviation; BMI = body mass index; ASA = American Society of Anesthesiologists; INR = international normalized ratio.			
Footnote: Percentages use non-missing denominators for each variable; totals may not sum to the full cohort.			

Baseline characteristics	TURP (N = 76,983)	Re-TURP (N = 6,556)	p-value
Preoperative platelet count ($\times 10^3/\mu\text{L}$), mean (SD)	227.9 (72.9)	222.7 (71.0)	< 0.001
Abbreviations: ACS = American College of Surgeons; TURP = transurethral resection of the prostate; re-TURP = repeat transurethral resection of the prostate; SD = standard deviation; BMI = body mass index; ASA = American Society of Anesthesiologists; INR = international normalized ratio.			
Footnote: Percentages use non-missing denominators for each variable; totals may not sum to the full cohort.			

Postoperative outcomes

Operative time was shorter for re-TURP (mean 49 vs 57 minutes; $p < 0.001$) (Table 2). Thirty-day complication rates were low, with UTI being the most frequent complication in both groups (5.4% after primary TURP and 5.0% after re-TURP), without a significant between-group difference (Table 2). Unplanned return to the operating room was more common after re-TURP (2.7% vs 2.1%; $p = 0.004$), and readmission rates were similar (5.6% vs 5.7%; $p = 0.749$).

Table 2

Thirty-day postoperative outcomes in patients undergoing primary versus repeat transurethral resection of the prostate (ACS National Surgical Quality Improvement Program Database 2013–2023)

Postoperative outcomes	TURP (N = 76,983)	Re-TURP (N = 6,556)	p-value
Operative time (minutes), mean (SD)	57 (38)	49 (36)	< 0.001
Total length of hospital stay (days), mean (SD)	1.7 (3.9)	1.8 (4.2)	0.048
Days from operation to discharge, mean (SD)	1.3 (2.4)	1.4 (2.6)	< 0.001
Urinary tract infection, n (%)	4,135 (5.4)	330 (5.0)	0.255
Sepsis/septic shock, n (%)	932 (1.2)	74 (1.1)	0.601
Pneumonia, n (%)	291 (0.4)	22 (0.3)	0.664
Organ/space surgical site infection, n (%)	169 (0.2)	13 (0.2)	0.829
New/progressive renal insufficiency, n (%)	247 (0.4)	31 (0.5)	0.067
Venous thrombosis requiring therapy, n (%)	199 (0.3)	13 (0.2)	0.422
Pulmonary embolism, n (%)	141 (0.2)	11 (0.2)	0.897
Cardiac arrest, n (%)	89 (0.1)	10 (0.2)	0.516
Myocardial infarction, n (%)	226 (0.3)	16 (0.2)	0.551
Stroke/CVA, n (%)	91 (0.1)	10 (0.2)	0.560
Blood transfusion, n (%)	1,130 (1.5)	125 (1.9)	0.006
Postoperative hematuria-related diagnoses, n (%)	823 (1.3)	181 (3.5)	< 0.001
Readmission, n (%)	4,401 (5.7)	368 (5.6)	0.749
Unplanned return to the operating room, n (%)	1,629 (2.1)	175 (2.7)	0.004
Footnote: Percentages use non-missing denominators for each variable; totals may not sum to the full cohort. Hematuria-related ICD-10 diagnoses were derived from the single postoperative ICD-10 diagnosis code recorded in NSQIP and prespecified in Supplementary Table 1.			
Abbreviations: ACS = American College of Surgeons; TURP = transurethral resection of the prostate; re-TURP = repeat transurethral resection of the prostate; SD = standard deviation; CVA = cerebrovascular accident; OR = operating room.			
Abbreviations: OR = odds ratio; CI = confidence interval; ASA = American Society of Anesthesiologists; UTI = urinary tract infection; TURP = transurethral resection of the prostate.			

Predictors of bleeding complications

Unadjusted transfusion rates were higher after re-TURP than after primary TURP (1.9% vs 1.5%; $p = 0.006$) (Table 2) and remained significant on univariable analysis (Fig. 1A). However, after adjustment for patient factors, the association was no longer significant (aOR 1.09; 95% CI 0.87–1.36; $p = 0.433$) (Fig. 1B).

Postoperative hematuria, defined by hematuria-related ICD-10 codes within 30 days (Supplementary Table 1), was more frequent after re-TURP (3.5% vs 1.3%; $p < 0.001$) and remained significant after adjustment (aOR 2.42; 95% CI 2.03–2.88; $p < 0.001$).

On univariable analysis, clinical acuity and baseline risk factors were associated with both bleeding endpoints (Fig. 1A). In multivariable models, older age, urgent/emergent surgical status, bleeding disorder, and lower preoperative hematocrit were independent predictors of both bleeding endpoints (Fig. 1B). Re-TURP was independently associated with postoperative hematuria but not transfusion. Longer operative time was associated with transfusion but not hematuria.

Predictors of return to the operating room and readmission

Multivariable analyses of downstream complications included 59,594 patients with available data (1,316 returns to the operating room and 3,541 readmissions) (Table 3). ASA class IV–V, urgent/emergent surgical status, bleeding disorder, preoperative UTI, and transfusion were independently associated with both outcomes (all $p < 0.01$). Transfusion showed the strongest association with return to the operating room (aOR 7.21; 95% CI 5.83–8.88; $p < 0.001$) and was strongly associated with readmission (aOR 2.05; 95% CI 1.70–2.45), second only to preoperative UTI (aOR 4.58; 95% CI 3.83–5.44; $p < 0.001$).

Postoperative hematuria was associated with return to the operating room (aOR 1.50; 95% CI 1.10–2.01; $p = 0.009$), but not with readmission. Re-TURP had slightly lower odds of readmission (aOR 0.87; 95% CI 0.76–0.99; $p = 0.040$) and was not associated with return to the operating room. Because NSQIP captures a single postoperative diagnosis code and only 30-day outcomes, temporality between hematuria coding and return to the operating room cannot be definitively established.

Table 3

Multivariable logistic regression analysis of predictors of return to the operating room and readmission after primary and repeat TURP (ACS NSQIP 2013–2023)

Variable	Return to operating room <i>n</i> = 59,594; events = 1,316		Readmission <i>n</i> = 59,593; events = 3,541	
	aOR (95% CI)	<i>p</i> -value	aOR (95% CI)	<i>p</i> -value
Age, per year	1.00 (0.99, 1.00)	0.252	1.02 (1.01, 1.02)	< 0.001
ASA class ≥ IV	1.57 (1.30, 1.88)	< 0.001	1.63 (1.45, 1.83)	< 0.001
Urgent/emergent surgery	1.75 (1.30, 2.30)	< 0.001	1.25 (1.02, 1.52)	0.030
Bleeding disorder	2.45 (2.00, 2.97)	< 0.001	1.79 (1.55, 2.05)	< 0.001
Preoperative UTI	1.92 (1.34, 2.68)	< 0.001	4.58 (3.83, 5.44)	< 0.001
Preoperative hematocrit	0.99 (0.98, 1.00)	0.205	0.96 (0.96, 0.97)	< 0.001
Operative time, per minute	1.00 (1.00, 1.00)	0.107	1.00 (1.00, 1.00)	0.168
Transfusion	7.21 (5.83, 8.88)	< 0.001	2.05 (1.70, 2.45)	< 0.001
Postoperative hematuria	1.50 (1.10, 2.01)	0.009	1.24 (0.99, 1.54)	0.051
Re-TURP	1.14 (0.93, 1.39)	0.185	0.87 (0.76, 0.99)	0.040
Adjusted ORs (95% CIs) and <i>p</i> -values for 30-day return to the operating room and readmission. Transfusion was independently associated with both outcomes; hematuria was associated with return to the operating room only. Re-TURP showed slightly lower odds of readmission.				
Abbreviations: aOR = adjusted odds ratio; CI = confidence interval; ASA = American Society of Anesthesiologists; UTI = urinary tract infection.				

Discussion

Dedicated registry studies comparing the complication profiles of primary TURP and re-TURP are limited. Prior reports often pooled the two procedures [17] or compared them only within broader analyses of BPH procedures [10, 11], typically using transfusion as the bleeding endpoint. Because transfusion may undercapture lower-severity bleeding [12], we complemented it with a prespecified ICD-10-based postoperative hematuria endpoint, compared both bleeding outcomes between primary TURP and re-TURP, and assessed their associations with downstream outcomes.

In more than 83,000 cases, re-TURP was independently associated with postoperative hematuria (aOR 2.42; 95% CI 2.03–2.88) but not transfusion. The persistence of the hematuria association despite the absence of an adjusted transfusion difference suggests that re-TURP may increase lower-severity bleeding-related morbidity without proportionally increasing major bleeding. Absolute differences were small, with hematuria occurring in 3.5% versus 1.3% and transfusion in 1.9% versus 1.5% after re-TURP

and primary TURP, respectively. These findings clarify prior reports that suggested small absolute transfusion differences [10, 11] by demonstrating loss of significance after adjustment and extend them by incorporating a bleeding proxy that remained significant. In our cohort, patient factors most strongly associated with bleeding included low preoperative hematocrit, case urgency, and bleeding disorder. Transfusion, which is known to be influenced by patient physiology, case urgency, and institutional thresholds [18], consistently predicted return to the operating room and readmission, whereas hematuria primarily tracked with re-intervention. Tissue changes in recurrent BPH, including altered vascularity and stromal remodeling, have been linked to symptomatic preoperative bleeding [19] and may contribute to higher postoperative hematuria without increasing major bleeding.

Readmission rates were comparable overall and lower than in some prior cohorts [20]. Age and urgent/emergent case status predicted readmission, consistent with population-based data [21], as did transfusion, preoperative UTI, and lower hematocrit. The lack of association between hematuria-coded diagnoses and readmission supports their lower-severity profile.

We also identified patient- and presentation-level predictors of both bleeding endpoints. Urgent/emergent surgical status and lower preoperative hematocrit were associated with both outcomes, likely reflecting reduced physiologic reserve, active bleeding, or limited preoperative optimization. Longer operative time was associated with transfusion, and older age with both endpoints, consistent with prior studies [22–24]. Preoperative UTI did not independently predict bleeding after adjustment, despite suggestions that infection may increase bleeding risk [25], but it strongly predicted readmission, implying predominant impact through non-bleeding morbidity.

These results have practical implications for counseling and perioperative pathways. In patients at elevated bleeding risk, optimizing hematocrit and deferring non-urgent cases when feasible may mitigate both transfusion and hematuria. For patients with high bleeding propensity or on mandatory antithrombotic therapy, alternative modalities with lower bleeding risk, such as laser-based techniques, may offer advantages. Structured post-discharge follow-up focused on early hematuria management may reduce returns to the operating room.

This retrospective registry study is subject to selection bias and residual confounding. NSQIP lacks urology-specific determinants of bleeding risk and procedural complexity, such as prostate size or resection weight [22], TURP modality [26], and antithrombotic use, thereby limiting risk adjustment and mechanistic inference. We could not link index and repeat procedures longitudinally or ascertain time since prior resection. Complete-case analyses excluded many observations; to mitigate bias from missing urgency, we modeled “missing” as a separate category, but residual bias may persist. In addition, the NSQIP constraint of a single postoperative diagnosis may displace hematuria when other complications occur, biasing results toward under-ascertainment. Future studies should validate hematuria-coded events against chart-adjudicated bleeding, incorporate urology-specific variables and antithrombotic data, and test sensitivity to alternative definitions, such as catheter interventions and clot evacuation.

In conclusion, re-TURP was associated with more hematuria-coded events but not a higher adjusted transfusion risk compared with primary TURP, suggesting an increase in lower-severity bleeding rather than major bleeding. Older age, urgent/emergent surgical status, bleeding disorder, and lower preoperative hematocrit identified patients at higher bleeding risk. These findings suggest that perioperative bleeding risk is driven more by patient condition and procedural context than by repeat resection status alone. Counseling and perioperative planning should therefore address both the increased likelihood of hematuria after re-TURP and targeted optimization of high-risk patients. Further validation of the hematuria-coded endpoint using urology-specific data is needed before stronger causal inferences can be drawn.

Declarations

Human Ethics and Consent to Participate

Not applicable.

Competing Interests

The authors declare no competing interests.

Personal financial interests

None.

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Author Contribution

M.D. and C.F. had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: M.D., C.F., K.W., D.L. Acquisition of data: C.F., M.D. Analysis and interpretation of data: M.D., C.F., E.L., N.B. Drafting of the manuscript: M.D., C.F., N.B. Critical revision of the manuscript for important intellectual content: M.D., C.F., E.L., K.W., D.L., N.B. Statistical analysis: M.D., C.F., E.L., K.W. Data visualization and figure preparation: M.D., C.F. Obtaining funding: None. Administrative, technical, or material support: None. Supervision: C.F., D.L. Other: None.

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Data availability

The data supporting this study's findings are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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Figures

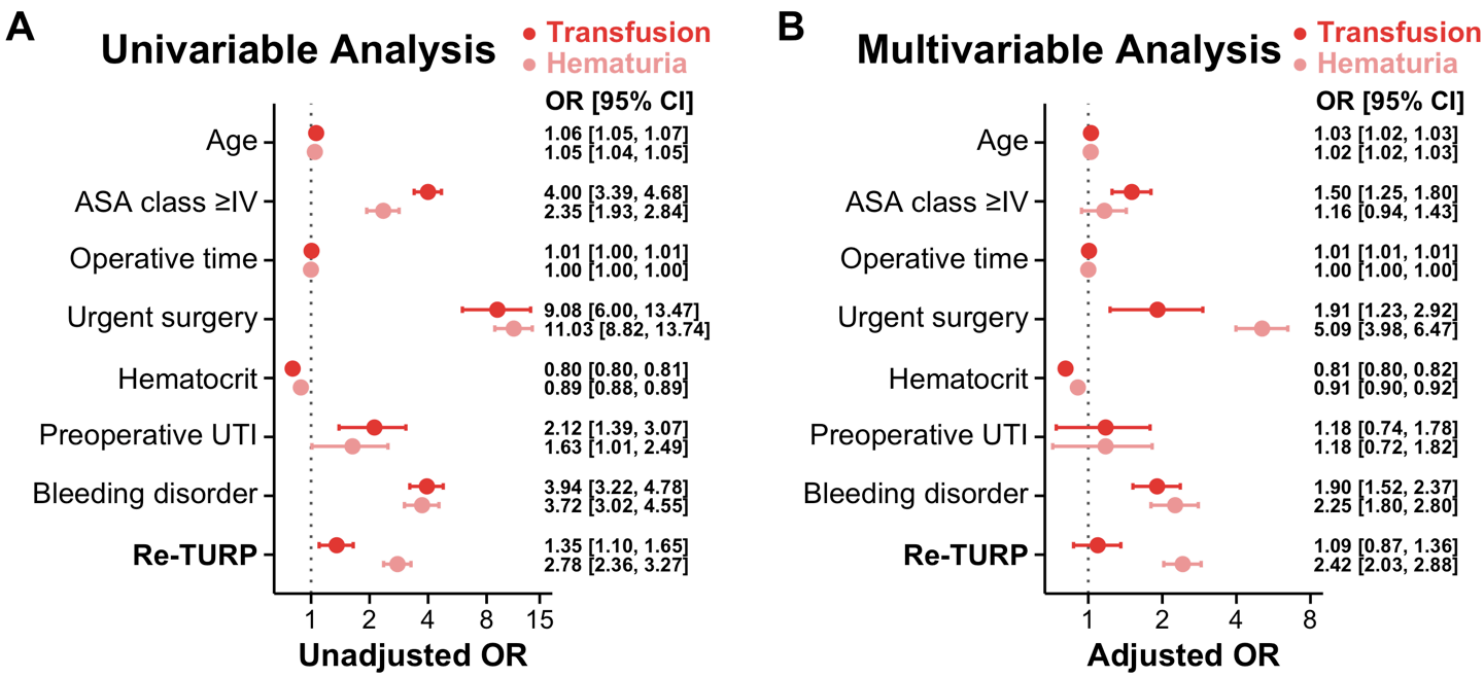


Figure 1

Predictors of postoperative transfusion and hematuria after primary versus repeat TURP (ACS National Surgical Quality Improvement Program Database 2013–2023)

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [SupplementaryTable1.xlsx](#)