A nationwide analysis of re-operation after kidney transplant

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Abstract

Introduction: We aimed to report the rate and short-term outcomes of patients undergoing re-operation following kidney transplant in the U.S.

Methods: The Nationwide Inpatient Sample (NIS) database was used to examine the clinical data of patients undergoing kidney transplant and re-operation during same the hospitalization from 2002–2012. Multivariate regression analysis was performed to compare outcomes of patients with and without re-operation.

Results: We sampled a total of 35 058 patients who underwent kidney transplant. Of these, 770 (2.2%) had re-operation during the same hospitalization. Re-operation was associated with a significant increase in mortality (30.4% vs. 3%; adjusted odds ratio [AOR] 4.62; p<0.01), mean total hospital charges ($249 425 vs. $145 403; p<0.01), and mean hospitalization length of patients (18 vs. 7 days; p<0.01). The most common day of re-operation was postoperative Day 1. Hemorrhagic complication (64.2%) was the most common reason for re-operation, followed by urinary tract complications (9.9%) and vascular complications (3.6%). Preoperative coagulopathy (AOR 3.35; p<0.01) was the strongest predictor of need for re-operation, hemorrhagic complications (AOR 3.08; p<0.01), and vascular complications (AOR 2.50; p<0.01). Also, hypertension (AOR 1.26; p<0.01) and peripheral vascular disorders (AOR 1.25; p=0.03) had associations with hemorrhagic complications.

Conclusions: Re-operation after kidney transplant most commonly occurs on postoperative Day 1 and occurs in 2.2% of cases. It is associated with significantly increased mortality, hospitalization length, and total hospital charges. Hemorrhage is the most common complication. Preoperative coagulopathy is the strongest factor predicting the need for re-operation, vascular complications, and hemorrhagic complications.

Introduction

Unplanned re-operation is an important quality of care measurement in surgical units, as it is associated with a significant increase in morbidity, mortality, and hospitalization length of stay.[1-3] Comorbid conditions, surgical errors, and perioperative factors are all known to be associated with unplanned re-operation.[2] Although there is some understanding of these issues, further investigation of the causes driving unplanned re-operation can improve surgical techniques and surgical outcomes.

Kidney transplantion is an established procedure with a high worldwide success rate.[4] Although transplant rejection was once regarded as the primary issue regarding transplant success, the use of modern immunosuppression has reduced graft loss due to acute and chronic rejection.[4] With the incidence of acute rejection being less than 1%, surgical complications are becoming more important causes of graft loss after kidney transplantation.[4] In addition, the standardization of surgical techniques and the increase in surgeons' clinical experience has helped reduce the number of surgical complications.[5] By investigating unplanned re-operations after kidney transplantation, we aim to evaluate the status and trends within kidney transplant surgery over time.

Methods

A retrospective analysis of the Nationwide Inpatient Sample (NIS) database from 2002–2012 was used in this study. NIS is a large inpatient care database maintained by the Agency for Healthcare Research. This American database contains information on more than 8 million hospital admissions each year.[6] Informed consent for participation in the NIS is obtained from patients within the individual hospitals' consent forms. This study investigates unplanned re-operation after kidney transplant during the same hospitalization from 2002–2012 in the U.S. Patients who underwent kidney transplant were extracted from the database using the International Classification of Diseases, 9th Revision, clinical modifications (ICD-9-CM) procedure codes of 55.6, 55.61, and 55.69 for kidney transplant. Indications for kidney transplant were extracted using ICD-9-CM diagnosis codes from the database. Unplanned re-operation was defined as the need to bring a patient back to the operating room due to complications from kidney transplant.

Demographic data, comorbidities, hospitalization length, total hospital charges, admission type, indication of kidney transplant, reasons for re-operation, and outcomes of patients were all gathered. Each variable was defined by its respective ICD-9 diagnosis code.[7] Kidney transplant rates, trends, reasons, and outcomes of re-operation were generated. Reasons for unplanned re-operation were obtained from the database according to the ICD-9 diagnosis codes reported as the second to 25th diagnosis for each patient. The risk adjusted analysis was performed to investigate predictors and outcomes of re-operation after kidney transplant.

Statistical analysis

Statistical Package for Social Sciences (SPSS) software, Version 22 (SPSS Inc., Chicago, , U.S.) was used for statistical analyses. The associations of re-operation with each postoperative complication were examined using a multivariable logistic regression model with all study variables as covariates. The estimated adjusted odds ratio (AOR) was calculated for each correlation with a 95% confidence interval (CI). The level of significance was set at $p<0.05$.

Results

We identified 35 058 patients who underwent kidney transplant from 2002–2012 within the NIS database. The majority of the patients were male (60.2%) and Caucasian (53.8%), with the median age being 50 years. The most common indications for kidney transplant were hypertension (42%) and diabetes (34.7%). The most common comorbidities other than the primary disease were iron deficiency anemia (41.2%) and fluid/electrolyte disorders (31.8%). The median hospitalization length was six days. Demographics and clinical characteristics of patients are shown in Table 1.

Among patients who underwent kidney transplant, 770 (2.2%) had unplanned re-operation during the same hospitalization. The most common day of re-operation was the first day after transplantation (Fig. 1). Hemorrhagic complications (64.2%) and urinary tract complications (9.9%) were the most common reasons for re-operation after kidney transplant (Fig. 2). The overall mortality and morbidity of patients who underwent kidney transplantation were 0.4% and 56.1%, respectively; however, patients with re-operation had significantly higher mortality and morbidity (Table 2).

Re-operation significantly increased hospitalization length (median 18 vs. 7 days; $p<0.01$) and total hospital charges (median $249 425 vs. $145 403; $p<0.01$). The risk adjusted analysis of factors associated with re-operation after kidney transplant is reported in Table 3. Coagulopathy (AOR 3.35; $p<0.01$) and hypertension (AOR 1.88; $p<0.01$) were significantly associated with the need for re-operation. Patients who underwent kidney transplant due to complications of diabetes had the highest risk for re-operation (Table 3).

Multivariate analyses of common reasons for re-operation were performed to further identify predictors of re-operation after transplantation. For example, preoperative coagulopathy (AOR 3.08; $p<0.01$), peripheral vascular disorders (AOR 1.25; $p=0.03$), hypertension (AOR 1.26; $p<0.01$), and

Table 1. Demographics and clinical characteristics of patients underwent kidney transplant

Variables		Kidney transplant (Sample size=35 058)
Age	Mean±standard deviation (years)	48±16
	Median (years)	50
Sex	Female	13 931 (39.8%)
Race	White	15 640 (53.8%)
	Black or African American	6411(22.1%)
	Hispanic	4488 (15.4%)
	Asian	1317 (4.5%)
	Other	1195 (4.1%)
Comorbidity	Fluid and electrolyte disorders	11 048 (31.8%)
	Coagulopathy	2471 (7.1%)
	Deficiency anemia	14 329 (41.2%)
	Alcohol abuse	165 (0.5%)
	Liver disease	1064 (3.1%)
	Weight loss	435 (1.3%)
	Hypothyroidism	2671 (7.7%)
	Chronic pulmonary disease	1954 (5.6%)
	Obesity	2614 (7.5%)
	Congestive heart failure	1701 (4.9%)
	Peripheral vascular disorders	1678 (4.8%)
	Drug abuse	287 (0.8%)
Indication of kidney transplant	Hypertension	14 715 (42%)
	Diabetes mellitus	12 170 (34.7%)
	Previous kidney transplant failure	2148 (6.1%)
	Polycystic kidney disease	1144 (3.3%)
	Lupus erythematous	518 (1.5%)
	Other	4363 (12.4%)
Admission type	Elective	19 187 (54.8%)
	Non-elective	15 823 (45.2%)
Hospitalization length	Mean±standard deviation (days)	8±7
	Median (days)	6
Total hospital charges	Mean±standard deviation	$147 076±98 702
	Median	$124 311
Outcomes	Mortality	174 (0.5%)
	Overall morbidity	6448 (18.4%)

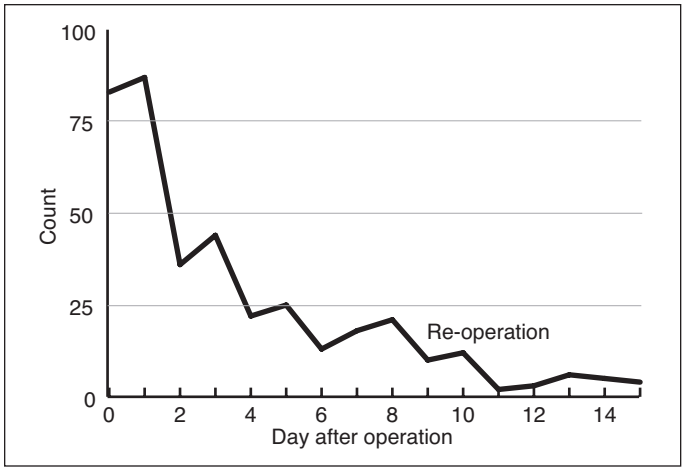

Fig. 1. Re-operation after kidney transplant.

non-elective admission (AOR 1.32; p<0.01) were associated with hemorrhagic complications. Coagulopathy (AOR 2.50; p<0.01) and age (AOR 0.97; p<0.01) were significantly associated with vascular complications. Coagulopathy (AOR 1.26; p=0.02) and non-elective admission (AOR 1.25; p<0.01) were significantly associated with urinary tract complications. Also, the risk of wound disruption was significantly higher in patients with preoperative weight loss (AOR 4.40; p<0.01).

Discussion

This study found a significant increase in mortality, morbidity, and graft failure rate in patients who had unplanned re-operation following kidney transplant. Strategies that decrease postoperative complications following re-exploration are beneficial for these patients. Wound negative pressure therapy[8,9] and tension sutures[10] to protect the surgical site,[11-13] and intensive lung expansion interventions are examples of such preventative strategies.

We found 2.2% of patients who underwent kidney transplant underwent re-exploration, which is lower than the 3.5% reported rate for unplanned re-operation following general surgery procedures.[1] We also found a decrease in the rate of unplanned re-operation after kidney transplantation. This rate dropped from 2.8% in 2002 to 1.9% in 2012. Improvements in operative techniques and non-surgical treatments of postoperative complications likely explain this phenomenon.[14]

Hemorrhagic complications are the most common reason for re-operation after kidney transplantation. Our results show that hemorrhagic complications were the indication for 64.2% of re-operated cases. Although these complications are difficult to prevent, other significant predictors of re-operation, like coagulopathy and hypertension, can easily be controlled perioperatively, and may decrease the rate of unplanned re-operation. Unfortunately, the benefits of correcting coagulopathies before transplantation is challenging because renal failure patients are prone to both bleeding disorders and hypercoagulability.[15] There is limited information regarding the reasons why some patients develop bleeding problems while others develop excessive thrombus formation.[15] Bleeding disorders can result from the insufficient function of platelets, the coagulation cascade, or the activation of the fibrinolytic system.[15-17] In contrast, hypercoagulability can result from platelet hyperactivity or disorders of coagulation regulatory factors.[15-17] With kidney transplant recipients easily tipped towards bleeding or thrombotic complications,

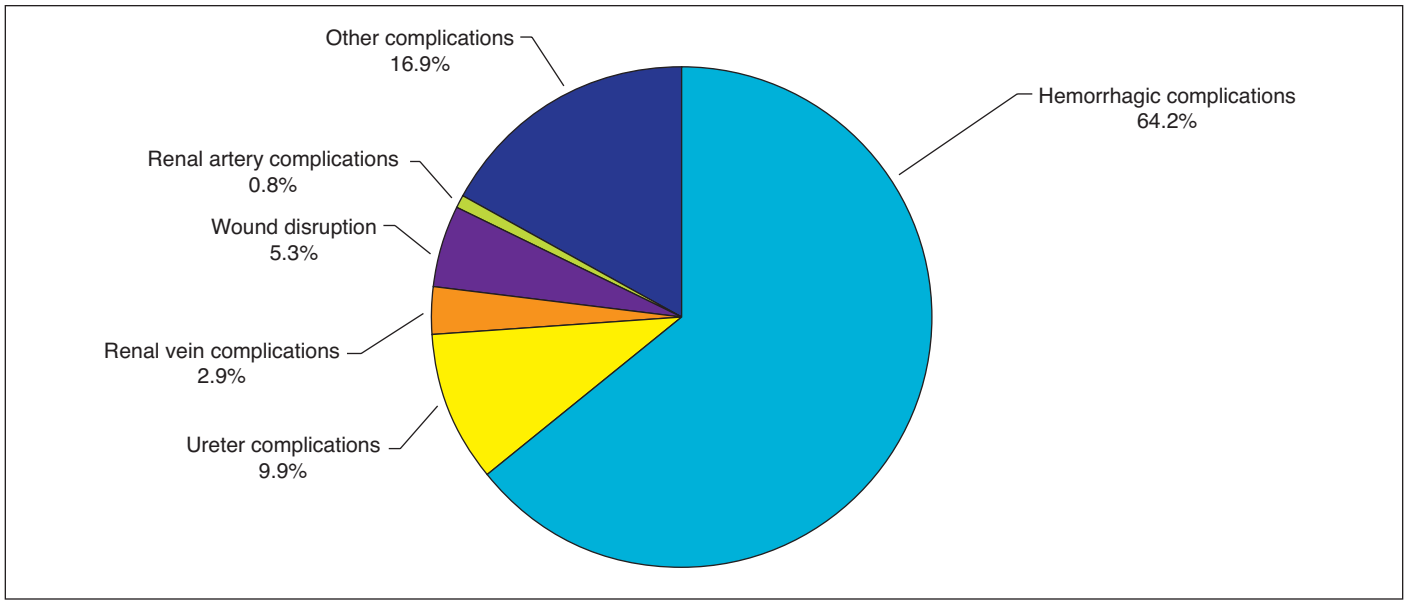

Fig. 2. Reasons for unplanned re-operation after kidney transplant.

Table 2. Postoperative complications of patients who underwent kidney transplantation

Complications	Patients with re-operation (770)	Patients without re-operation (34 288)	Adjusted odds ratio	95% confidence interval	p
Mortality	23 (3%)	151 (0.4%)	4.62	2.88–7.40	<0.01
Overall morbidity*	371 (48.2%)	6077 (17.7%)	3.50	3.01–4.08	<0.01
Transplanted kidney failure or rejection	176 (22.9%)	2705 (7.9%)	2.86	2.39–3.44	<0.01
Prolonged ileus	101 (13.1%)	1563 (4.6%)	2.52	2.01–3.16	<0.01
Urinary tract infection	57 (7.4%)	1315 (3.8%)	1.62	1.22–2.15	<0.01
Wound infection	59 (7.7%)	228 (0.7%)	8.54	6.22–11.73	<0.01
Pneumonia	32 (4.2%)	358 (1%)	2.58	1.74–3.81	<0.01
Hospitalization >30 days	87 (11.3%)	326 (1%)	7.84	5.94–10.34	<0.01
Acute myocardial infarction	42 (5.5%)	650 (1.9%)	2.31	1.65–3.22	<0.01
Acute respiratory failure	36 (4.7%)	370 (1.1%)	2.70	1.86–3.92	<0.01
Deep vein thrombosis	11 (1.4%)	89 (0.3%)	3.63	1.88–7.01	<0.01

*Includes: transplanted kidney failure or rejection, prolonged Ileus, urinary tract infection, wound infection, pneumonia, hospitalization more than 30 days, acute myocardial infarction, acute respiratory failure, and deep vein thrombosis.

the goals and indications for correcting coagulation factors before or during kidney transplantation needs to be defined.

Our study results show that urinary anastomosis complications are the second most common reason for unplanned re-operation following kidney transplant. Surprisingly, 80.5% of urinary anastomosis complications are managed non-surgically in this study. Percutaneous techniques are currently considered first-line treatments for urological complications from kidney transplantation.[14] Factors such as long dialysis duration and ureter ischemia are reported risk factors for ureter anastomosis complications.[18] Although the best technique for donor ureter anastomosis remains unclear, the preservation of adventitia, fat, and blood supply to the ureter through delicate dissection, and use of short ureters, and fixation of the adventitia, fat, and blood supply of the ureter to the bladder wall to prevent kinking or twisting are methods explored to reduce complications from donor ureter anastomosis.[19,20]

Table 3. Risk adjusted analysis of re-operation predictors of patients who underwent kidney transplantation

Variables		Adjusted odds ratio	95% confidence interval	p
Age	Age	0.99	0.98–0.99	<0.01
Sex	Female	1.03	0.88–1.20	0.66
Comorbidity	Obesity	0.58	0.41–1.00	0.07
	Coagulopathy	3.35	2.78–4.04	<0.01
	Hypertension	1.88	1.52–2.33	<0.01
	Diabetes mellitus	0.76	0.60–1.00	0.09
	Fluid and electrolyte abnormalities	1.57	1.35–1.82	<0.01
	Chronic lung disease	0.75	0.52–1.08	0.13
	Drug abuse	1.07	0.49–2.32	0.85
	Weight loss	2.68	1.85–3.87	<0.01
	Alcohol abuse	0.53	0.13–2.21	0.39
	Deficiency anemia	0.63	0.54–1.00	0.06
	Congestive heart failure	1.42	1.07–1.87	0.01
	Peripheral vascular disorders	1.03	0.73–1.44	0.85
	Hypothyroidism	0.67	0.48–1.00	0.06
	Liver disease	1.28	0.89–1.85	0.18
Admission type	Non-elective	Reference	Reference	Reference
	Elective	0.72	0.62–0.84	<0.01
Indication of transplant	Hypertension	Reference	Reference	Reference
	Diabetes mellitus	1.44	1.13–1.83	<0.01
	Previous kidney transplant failure	1.34	1.01–1.90	0.04
	Polycystic kidney disease	0.57	0.29–1.15	0.12
	Lupus erythematous	1.80	0.78–4.18	0.16

Vascular complications are rare, but severe problems following kidney transplantation. Although 0.6% of transplanted patients developed vascular complications in our study, these patients were responsible for 23.1% of transplanted kidney failures. This is consistent with the report of vascular complications as the third most common reason for graft failure following kidney transplantation by Keller et al.[21] The identification of predictors of vascular complications may decrease the rate of complications in transplanted patients. In our study, we found that age and coagulation disorders were two factors associated with vascular complications. Patient age has been previously reported as one of the most significant risk factors for developing vascular thrombosis after kidney transplantation;[21] however, there is no specific guideline to correct coagulation disorders before kidney transplantation. Despite difficulties in controlling predictors of vascular complications of kidney transplant, the new interventional techniques avoid re-operation in most cases.[14,22] Primary technical success using interventional techniques was reported to be obtained in 74% of patients with kidney transplantation complications.[22] In addition, new imaging modalities allow early diagnosis of vascular complications and better prognosis after intervention.[14,22]

Study limitations

Data in this study was extracted from an inpatient database that lacked information regarding long-term outcomes of patients who underwent re-operation. Procedure details, such as the number of donor arteries, size of donor arteries and veins, status of recipient vessels, and size of recipient bladder — all factors that can affect the result of transplantation — were not accessible. The retrospective nature of the study makes definitive conclusions difficult, so randomized, clinical trials are needed to confirm and explore our results. Although results were adjusted for multiple factors, surgical techniques and intraoperative factors, such as warm and cold ischemia times, are not included in the database. Patients in this study did not form a homogeneous group and their primary diagnoses varied broadly. The data in this study was extracted from discharge data, so coding errors may have potentially occurred.[23] Despite these limitations, this study is one of the largest studies using multivariate analysis to report reasons and outcomes of patients undergoing re-operation after kidney transplant.

Conclusion

Re-operation after kidney transplant is uncommon; however, it is associated with significantly increased mortality, hospitalization length, and total hospital charges. The most common reason for re-operation was hemorrhagic complications and the most common day of re-operation was postoperative Day 1. Preoperative coagulopathy was the strongest factor predicting the need for re-operation, vascular complications, and hemorrhagic complications. The goal and indication for correcting coagulation factors before or during kidney transplantation should be defined.

Competing interests: The authors report no competing personal or financial interests.

This paper has been peer-reviewed.

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