Never events and hospital-acquired conditions after kidney transplant

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Abstract

Introduction: Never events (NE) and hospital-acquired conditions (HAC) after surgery have been designated as quality metrics in healthcare by the Centres for Medicare and Medicaid Services (CMS).
Methods: The Nationwide Inpatient Sample (NIS) database 2002–2012 was used to identify patientswho underwent kidney transplant. Multivariate analysis using logistic regression was used to identify outcomes and risk factors of HAC and NE after transplantation; however, we were limited by using a retrospective database missing some important variables specified for the kidney transplant, such as some operative factors, donor factors, and cold and warm ischemia times.
Results: Among 35 058 patients who underwent kidney transplant, there were 11 NEs, all of which were due to retained foreign bodies. Among HAC after surgery, falling was the most common (44.9%), followed by poor glycemic control (21.7%), vascular catheter-associated infection (21%), and catheter-associated urinary tract infection (8%). HAC and NE after surgery lead to a significant increase in mortality (adjusted odds ratio [AOR] 2.49; p=0.04), hospitalization length (13 vs. 7 days; p<0.01), and total hospital charges ($231 801 vs. $146 717; p<0.01). A significantly higher risk of HAC or NE was seen for patients who had more loss of function before surgey (AOR 3.25; p<0.01) and patients expected to have higher postoperative mortality before operation (AOR 1.62; p=0.03).
Conclusions: Despite the limitations of the study, we found HAC and NE significantly increase mortality, hospitalization length, and total hospital charges of kidney transplant patients. Quality improvement initiatives should target HAC and NE in order to successfully reduce or prevent these events.

Introduction

The quality and safety of patient care in hospitals are important aims of National Quality Forum (NQF) in the U.S.[1,2] As adverse, serious events that are largely preventable, never events (NE) and hospital-acquired conditions (HAC) are reliable measurements of the quality and safety of patient care.[1,2] NEs and HACs also have a significant financial impact on the U.S. healthcare system.[3] It has been estimated that payments for surgical NE amounted to over $1.3 billion from 1990–2010.[4] Eliminating surgical NEs is necessary to limit harm to patients.[4] Understanding the impact and frequency of these conditions can help to design the best preventative strategies.

NE was defined in 2006 by NQF, which includes 28 reportable events in healthcare.[2] The list includes obvious unacceptable errors; however, not all the events are indicative of obvious negligence.[2] A goal of quality improvement is the reduction of NEs to zero. In this line, Centres for Medicare and Medicaid Services (CMS) adopted the non-reimbursement policy for some of the events with the name of "non-reimbursable serious hospital-acquired conditions" in order to motivate hospitals to accelerate improvement of patient safety.[2] Investigating patient characteristics and operative factors with the events may help improve current prevention strategies. Using a nationwide database, this study aims to investigate predictors and outcomes of NE and HAC after kidney transplantation using appropriate events for the kidney transplant procedure according to both NQF and CMS lists.

Methods

An analysis of the Nationwide Inpatient Sample (NIS) database from 2002–2012 was used in this study. NIS is an inpatient care database according to hospital discharge data in the U.S. acquired by the Healthcare Cost and Utilization Project (HCUP) of the Agency for Healthcare Research and Quality, Rockville, MD. It is an annually compiled database that consists of approximately 8 million inpatient stays from approximately 1000 hospitals each year.[5] Informed consent is obtained from individual patients within the individual hospitals' patient consent forms. For the purposes of this study, NIS was queried using the Ninth Revision of the International Classification of Disease (ICD-9-CM) procedure code of 55.69 to identify kidney transplantation cases. ICD-9

diagnosis codes, which were reported in principal diagnosis of patients, were also used to identify relevant diagnoses of patients.This study investigated NEs and HACs after kidney transplantation using the ICD-9 diagnosis codes, which were reported as the second to 25th diagnosis of patients in the database. Details of the codes used to identify NE and HAC are reported in Table 1. The definition of complications (NE and HAC) were made according to ICD-9 diagnosis codes, which is available online.[6]

Patient variables include demographic data (age, sex, and race), patient diagnosis, comorbidities (hypertension, coagulopathy, and diabetes mellitus), hospitalization length, total hospital charges, and admission type (elective vs. non-elective). Patient loss of function before surgery and risk of mortality (mild, moderate, major, and extreme) were according to the classification of the NIS database.[5] The primary endpoints were rates of NE and HAC after kidney transplantation. Secondary endpoints were predictors and outcomes of NE and HAC after kidney transplantation. Risk adjusted analysis was performed to investigate predictors and outcomes of NE and HAC.

Statistical analysis

Data was analyzed using the Statistical Package for Social Sciences (SPSS) software, Version 22 (SPSS Inc., Chicago, IL, U.S.). The main analysis was multivariate analysis using logistic regression. The associations of NE and HAC with mortality and morbidity of patients were examined using a multivariable logistic regression model. We included all the variables of the study as covariates in the model. The estimated adjusted odds ratio (AOR) with a 95% confidence interval (CI) was calculated for each correlation. Statistical hypotheses were tested using $p<0.05$ as the level of statistical significance.

Table 1. Hospital-acquired conditions and never events identification codes

Diagnosis	ICD-9 codes
Hospital-acquired conditions (HAC)	
Air embolism	999.1
Blood incompatibility	999.60, 999.61, 999.62, 999.63, 999.69
Pressure ulcer stages III & IV	707.23, 707.24
Falls and trauma	800–829, 830–839, 850–854, 925–929, 940–949, 991–994
Catheter-associated urinary tract infection	996.64
Vascular catheter-associated infection	999.31, 999.32, 999.33
Poor glycemic control	250.10–250.13, 250.20–250.23, 251.0, 249.10–249.11, 249.20–249.21
Never events	
Retained foreign body	E871.0, E871.9, 998.4, 998.7
Wrong operation on correct patient	E876.5
Wrong operation intended for another patient	E876.6
Correct operation on wrong body part/site	E876.7

Results

We sampled 35 058 patients who underwent kidney transplant from 2002–2012 accordng to the NIS database. Of these, 60.2% were male. The median age of patient was 50 years. Also, the majority of patients were Caucasian (53.8%). Deficiency anemia (41.2%) and fluid and electrolyte disorders (31.8%) were the most common reported comorbid conditions of patients. The median hospitalization length of patients was six days. The most common reported reasons of renal failure and need for kidney transplant were hypertension (42%) and diabetes (34.7%). Demographics and clinical characteristics of patients are shown in Table 2.

Among patients who underwent kidney transplant, 11 (0.03%) had NEs and all of the events were due to retained foreign bodies. Overall, 138 patients had postoperative HAC, of which falling was the most common event (44.9%), followed by poor glycemic control (21.7%), vascular catheter-associated infection (21%), catheter-associated urinary tract infection (8%), stages III and IV pressure ulcers (2.9%), and ABO incompatible blood transfusion (2.2%) (Fig. 1).

The mortality and morbidity of patients who underwent kidney transplantation were 0.5% and 24.3%, respectively. Patients with HAC or NE had significantly higher mortality (1.4% vs. 0.5%; $p=0.04$) and morbidity (45.6% vs. 24.2%; $p<0.01$). HAC and NE after surgery were significantly associated with an increased mean length of stay (13 vs. 7 days; $p<0.01$) and hospital charges of patients ($231 801 vs. $146 717; $p<0.01$). Also, patients with NE or HAC had a higher risk of unplanned reoperation (AOR 1.92; $p=0.04$), prolonged ileus (AOR 2.28; $p<0.01$), pneumonia (AOR 3.31; $p<0.01$), acute myocardial infarction (AOR 2.72; $p<0.01$), and respiratory failure (AOR 3.69; $p<0.01$) (Table 3).

Risk adjusted analysis of factors associated with postoperative NE and HAC are reported in Table 4. A significantly higher risk of HAC or NE events was seen for patients who had a severe disease before surgery (AOR 3.25; $p<0.01$) and patients who were expected to have more loss of function before surgey (AOR 1.62; $p=0.03$). When investigating patients who had catheter-related urinary tract infection, factors such as age (AOR 0.96; CI 0.92–0.99; $p=0.04$), female gender (AOR 15.48; CI 1.92–124.41; $p=0.01$), and severity of loss of function before surgey (AOR 9.70; CI 1.01–94.88; $p=0.04$) were significantly associated with catheter-related urinary tract infection. Also, severity of loss of function before

Table 2. Demographics and clinical characteristics of patients underwent kidney transplant with or without never events (NE) and hospital-acquired conditions (HAC)

Variables		Patients with NE or HAC	Patients without NE or HAC	p
Age	Mean±standard deviation (years)	48±16	47±15	<0.01
	Median (years)	50	50	----
Sex	Female	41.5%	39.8%	0.67
Race	White	65.9%	44.6%	<0.01
	Black or African American	20.3%	18.3%	0.64
	Hispanic	8.9%	12.8%	0.04
	Asian	0.8%	3.8%	0.97
	Other or unknown	4.1%	20.5%	0.04
Comorbidity	Fluid and electrolyte disorders	37.7%	31.8%	0.12
	Coagulopathy	12.3%	7.1%	0.01
	Deficiency anemia	40.4%	41.2%	0.84
	Diabetes	47.6%	23.9%	<0.01
	Liver disease	5.5%	3.1%	0.08
	Weight loss	2.1%	1.2%	0.38
	Hypertension	14.4%	10.8%	0.16
	Chronic pulmonary disease	5.4%	5.6%	0.94
	Obesity	5.5%	7.5%	0.34
	Congestive heart failure	5.4%	4.9%	0.74
	Peripheral vascular disorders	7.5%	4.8%	0.12
Preoperative expected mortality	Minor likelihood of dying	7.9%	32.5%	<0.01
	Moderate likelihood of dying	47.4%	46.7%	<0.01
	Major likelihood of dying	30.7%	17.8%	<0.01
	Extreme likelihood of dying	14%	3.1%	<0.01
Preoperative loss of function	Minor loss of function	3.5%	15.7%	<0.01
	Moderate loss of function	27.2%	46.6%	<0.01
	Major loss of function	45.6%	32.2%	<0.01
	Extreme loss of function	23.7%	5.5%	<0.01
Indication of kidney transplant	Hypertension	23.1%	42.1%	<0.01
	Diabetes mellitus	63.9%	34.6%	<0.01
	Previous kidney transplant failure	5.4%	6.1%	0.72
	Polycystic kidney disease	1.4%	3.3%	0.19
	Lupus erythematous	0%	1.5%	0.13
	Other	6.1%	12.4%	0.09
Admission type	Elective	54.4%	54.8%	0.92
	Non-elective	45.6%	45.2%	0.92
Hospitalization length	Mean±standard deviation (days)	13±11	7±7	<0.01
	Median (days)	8	6	<0.01
Total hospital charges	Mean±standard deviation	$231 801 ±216 093	$146 717 ±97 759	<0.01
	Median	$156 647	$124 184	<0.01
Outcomes	Mortality	1.4%	0.5%	<0.01
	Overall morbidity	45.6%	24.2%	<0.01

surgey was significantly associated with falling (AOR 3.14; CI 1.48–6.67; p<0.01), retained foreign body (AOR 7.58; CI 1.24–46.28; p=0.02), and vascular catheter-associated infection (AOR 6.82; CI 1.22–38.05; p=0.02). Poor glycemic control was significantly associated with patient's age (AOR 0.94; CI 0.91–0.98; p<0.01).

Discussion

This study found a significant increase in mortality, morbidity, hospitalization length, and total hospital charges of patients with NEs and HACs after kidney transplant. Also, the risks of other postoperative complications, such as prolonged ileus, pneumonia, acute myocardial infarction, and respiratory failure, increase in presense of NE and HAC. We reinforce the literatures reports on the severity effect of NE and HAC events on patient outcomes, as well as the significant increase in total hospital charges related to the events.[7-9]

Our study results show the severity of loss of function before surgey is a reliable factor to find patients at high risk for postoperative NE and HAC (Table 4). We found the risk of NE and HAC for patients with major or extreme loss of function before surgey is more than three times that of patients with minor or moderate loss of function before surgery. Patient characteristics have been reported

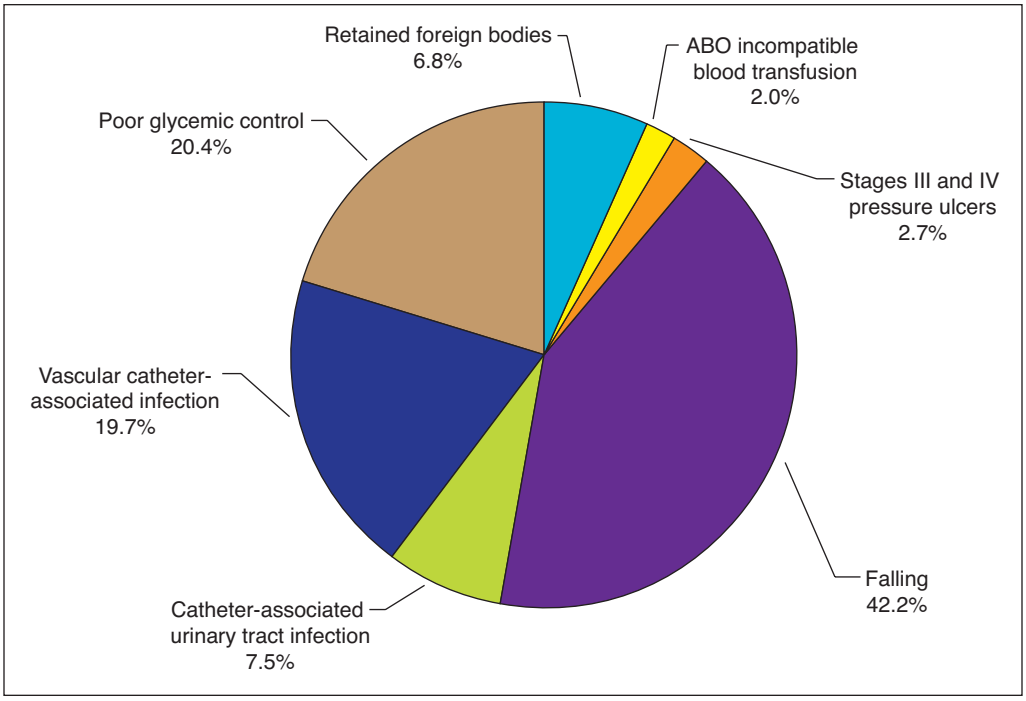

Fig. 1. Never events and hospital-acquired conditions after kidney transplant.

as important predictors of the occurrence of a NE in the literature.[10] Although preventive sterategies should be done for all surgical patients, some high-risk patients may benefit from frequent assessments to decrease the risk of NE during hospitalization. For example, creating a mandatory checklist that should be filled out frequently during hospitalization by the responsible surgeon may be useful in high-risk patients.[2]

We found a significant association between catheter-related urinary tract infection and age, female gender, and severity of loss of function before surgey, which is in line with literaure reports;[11,12] however, we could not evaluate correlation between urinary stent and length of using urinary catheter and urinay tract infection. It is estimated that up to 69% of catheter-related urinary tract infection can be prevented using appropriate infection prevention strategies, such as the removal of the catheter as soon as possible or avoidance of its use.[12-14] Considering 38% of physicians were not aware of the status of urinary catheter use for their patients,[12,15] reminder systems, including face-to-face reminders involving staff nurses and virtual reminders involving the use of electronic devices, may help decrease the risk of catheter-related urinary tract infection.[12]

Our study results show falling is the most common preventable HAC in kidney transplant patients. The overall reported rate of fall after general surgery procedures is 1.6% in literature;[16] we found a rate of 0.2% postoperative

Table 3. Risk adjusted analysis of postoperative complications of patients with or without never events (NE) and hospital-acquired conditions (HAC)

Complications	Patients with NE or HAC	Patients without NE or HAC	Adjusted odds ratio	95% confidence interval	p
Mortality	1.4%	0.5%	2.49	1.01–10.31	0.04
Overall morbidity*	45.6%	24.2%	2.44	1.74–3.42	<0.01
Transplanted kidney failure or rejection	10.2%	8.2%	1.23	0.71–2.12	0.45
Renal vascular complications	2.7%	0.6%	3.83	1.38–10.64	0.01
Wound disruption	3.4%	0.5%	5.74	2.28–14.41	<0.01
Hemorrhagic complications	7.5%	5.2%	1.28	0.68–2.41	0.43
Ureter complications	4.1%	3.4%	1.19	0.52–2.71	0.67
Unplanned reoperation	5.4%	2.2%	1.92	1.01–4.02	0.04
Prolonged ileus	10.9%	4.7%	2.28	1.34–3.88	<0.01
Urinary tract infection	15.6%	3.9%	4.03	2.54–6.41	<0.01
Wound infection	2.7%	0.8%	2.63	0.94–7.38	0.06
Pneumonia	4.1%	1.1%	3.31	1.43–7.67	<0.01
Hospitalization >30 days	8.2%	1.1%	6.16	3.22–11.79	<0.01
Acute myocardial infarction	6.1%	2%	2.72	1.36–5.44	<0.01
Acute respiratory failure	4.8%	1.1%	3.69	1.68–8.12	<0.01
Deep vein thrombosis	0%	0.3%	0.99	0.99–1.00	0.51

*Includes: Transplanted kidney failure or rejection, renal vascular complications, wound disruption, hemorrhagic complications, ureter complications, unplanned reoperation, prolonged ileus, urinary tract infection, unplanned reoperation, wound infection, pneumonia, hospitalization more than 30 days, acute myocardial infarction, acute respiratory failure, deep vein thrombosis.

Table 4. Risk-adjusted analysis of factors associated with postoperative never events and hospital-acquired conditions

Variables		Adjusted odds ratio	95% confidence interval	p
Age	Age	0.98	0.97–0.99	0.03
Sex	Female	1.10	0.75–1.61	0.61
Comorbidity	Obesity	0.48	0.19–1.20	0.12
	Coagulopathy	0.76	0.38–1.44	0.45
	Hypertension	0.89	0.50–1.58	0.70
	Diabetes mellitus	0.99	0.59–1.66	0.99
	Fluid and electrolyte abnormalities	0.78	0.52–1.18	0.24
	Chronic lung disease	0.94	0.41–2.16	0.89
	Weight loss	0.77	0.18–3.19	0.72
	Deficiency anemia	0.89	0.60–1.32	0.57
	Congestive heart failure	0.50	0.20–1.26	0.14
	Peripheral vascular disorders	1.05	0.51–2.24	0.87
	Liver disease	1.32	0.53–3.29	0.54
Preoperative expected mortality	Low or moderate likelihood of dying	Reference	Reference	Reference
	High or extreme high likelihood of dying	1.62	1.03–2.55	0.03
Preoperative loss of function	Minor or moderate loss of function	Reference	Reference	Reference
	Major or extreme loss of function	3.25	1.95–5.41	<0.01

falls for kidney transplant patients — lower than for general surgeries. Although a fall seems like a simple event, in the literature it represents a failure of multiple physiological systems and also a marker for increased perioperative mortality and morbidity and postoperative delirium.[16-19] Recognition of fall risk factors and identifying high-risk patients for fall will help design postoperative fall prevention programs. Factors like older age, functional dependence, and lower albumin levels have been reported to be associated with falls.[16] We also found a higher risk of fall for patients who had more loss of function before surgey. Interestingly, 66% of patients who fell had diabetes as a result of kiney failure. Diabetes with peripheral neuropathy can increase chance of fall after surgery. Minimizing polypharmacy and avoiding individual medications that increase the risk of delirium, increasing the presence of family members or sitters at the bedside, minimizing environmental hazards, and occupational and physical therapy training in high-risk patients, especialy in diabetetic patients with peripheral neuropathy, may decrease the risk of fall in high-risk patients.

We found vascular catheter-associated infection as the third most common HAC after kidney transplant. It has been estimated that there are 15 million central vascular catheter days for patients hospitalized at intensive care units each year in the U.S.[20,21] There are multiple studies that addressed catheter-related bloodstream infections in literature.[20,21] Factors such as the duration of catheterization and use of a semipermeable transparent dressing have been reported to be independently associated with positive cultures of catheters.[22] We found a significantly higher risk of vascular catheter-associated infection in patients who had more loss of function before surgey. Following guidelines for the prevention of intravascular catheter-related infections can decrease the risk of vascular catheter-associated infection in surgical patients.[21] Some evidence-based recommendations include: educating and designating trained healthcare personnel and assessing their knowledge and adherence to guidelines, correcting selection of catheters and sites, hand hygiene and aseptic techniques, maximal sterile barrier precautions, and appropriate catheter site dressing regimens.[21]

Our study results show poor glycemic control is the second most common HAC in kidney transplant patient and it is reversly associated with patient's age. Perioperative hyperglycemia has been reported as an adverse outcome predictor in surgical patients even in the non-diabetic population.[23,24] It has been reported that postoperative blood glucose greater than 140 mg/dL is present in as many as 40% of non-cardiac surgery patients and 25% of those patients have a blood glucose level greater than 180 mg/dL.[24] Checking the blood glucose in the morning of surgery in patients with and without a history of diabetes is recommended.[23] Blood glucose level of 150 mg/dl has been reported as the cutoff point for increasing risks of mortality, morbidity, and hospitalization length, particularly in those who do not have a prior diagnosis of diabetes.[24] Perioperative immunosupresive medications, such as corticosteroids and prograf, also can increase blood sugar of transplanted patients and make control of blood sugar in such patients difficult; however, further studies are indicated to determine whether strict perioperative blood glucose management improves clinical outcomes in transplanted patients.

Study limitations

There are limitations to the study. Detection of adverse events in the NIS database is limited to the ICD-9-CM coding system and coding error is possible.[25,26] Despite our attempts

to adjust for all possible confounders, we could not measure some variables that contribute to patient outcomes, such as warm and cold ischemia time, presence of urinary stent, effects of perioperative immunosupresive medications, and length of use of urinary catheter. The NIS dataset misses some potentially important explanatory variables, such as anatomic or laboratory data. Also, The NIS has no ability to follow patient outcomes longitudinally. Despite these limitations, the advantage of using the NIS database is the broad national geographic representation across all regions of the country and also the possibility of reporting weighted results as national outcomes.

Conclusion

HAC and NE after kidney transplantation are uncommon; however, they are associated with a significant increase in mortality, morbidity, hospitalization length, and hospital charges. Quality improvement initiatives should target HAC and NE in order to successfully reduce or prevent these events. The severity of loss of function before surgey is a reliable factor to identify patients at high risk for postoperative NE and HAC. Falling is the most common preventable HAC in kidney transplant patients. The severity of loss of function before surgey is significantly associated with falling, retained foreign body, catheter-related urinary tract infection, and vascular catheter-associated infection. The risks of poor glycemic control and catheter-related urinary tract infection significantly increase in the elderly. Following guideline recommendations in the prevention of HAC and NE may decrease the rates of NE and HAC in high-risk patients.

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This paper has been peer-reviewed.

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