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Is the Center for Medicare and Medicaid's Lack of Reimbursement for Postoperative Urinary Tract Infections in Elderly Emergency Surgery Patients Justified?

Martin D. Zielinski, MD, Kristine M. Thomsen, BA, Stephanie F. Polites, MD, Mohammad A. Khasawneh, MBBS, Donald H. Jenkins, MD, and Elizabeth B. Habermann, PhD

Department of Surgery; Mayo Clinic, Rochester, MN

Abstract

Objectives—Urinary tract infections (UTI), a risk factor for readmission, have been deemed a potentially preventable problem, and therefore not reimbursable, by the Centers for Medicare and Medicaid Services (CMS) since 2008. Defining the risk factors for UTI development in the postoperative period will provide risk stratification for UTI development in these challenging patients.

Methods—Pre-, intra-, and postoperative characteristics were collected for patients 65 years old who underwent an emergency abdominal operation from the 2005–2012 National Surgical Quality Improvement Program (NSQIP) Participant User File (PUF), a database of 374 participating hospitals. In-hospital UTIs occurring within 30 days of the operation were identified. Multivariable logistic regression analysis was conducted to identify UTI risk factors.

Results—In total, 53,879 patients were included, 1881 (3.5%) of whom were diagnosed with a postoperative UTI prior to discharge. In-hospital UTI was associated with a greater hospital stay (27 vs 13 days, $p<0.001$) and greater 30-day mortality rates (18% vs 16%, $p=0.003$). The rate of UTI dropped from 4.5% prior to the CMS decree to 3.2% thereafter ($p<0.001$). Multivariable logistic regression demonstrated advanced age, female sex, insulin-dependent diabetes mellitus, dependent functional status, open wound, hypoalbuminemia, elevated ASA class, operative approach, and prolonged operative time were independent risk factors for postoperative UTI development (Table).

Conclusion—While postoperative UTI rates dropped after the CMS decree, the lack of reimbursement is not justified as few modifiable risk factors to further improve postoperative UTI rates in elderly emergency surgical patients were identified. While targeted interventions may be

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Address correspondence to: Dr. Martin D. Zielinski Division of Trauma, Critical Care and General Surgery Mary Brigh 2-810 St. Mary's Hospital Mayo Clinic 1216 Second St. SW Rochester, MN 55902 Phone: (507) 255-2923 Fax: (507) 255-9873
zielinski.martin@mayo.edu.

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developed, this complication is not easily preventable and will continue to plague acute care surgeons taking care of this challenging patient population.

Introduction

Healthcare associated infections (HAI) account for 1,700,000 infections and 100,000 deaths every year in the United States.¹ In an effort to reduce these needless complications, the Centers for Medicare and Medicaid (CMS) created policies to introduce financial disincentives on physicians and institutions. These policies, broad ranging despite limited evidence in published literature, are, in general, supported by patient advocacy groups and physicians alike.² As the most common HAI, catheter associated urinary tract infections (UTI) are prime targets of this regulation and have been deemed “reasonably preventable” since the regulations took effect in 2008. As a result of this classification, catheter associated UTI Diagnosis Related Group (DRG) codes are not reimbursed by CMS and other associated health insurance organizations.^{3,4} The cost to institutions can be substantial as the number of hospital acquired UTIs are 449,000 per year with a lack of CMS reimbursement ranging from \$862–\$1,007 per UTI.^{1,5}

As the primary payer organization for elderly patients, CMS has the ability to define reimbursement strategies. While the goal of UTI reduction is admirable and desirable, is the elimination of UTI feasible? Almost synonymous with the CMS patient population is the presence of multiple comorbid conditions such as hypertension, diabetes mellitus, arthritis or coronary artery disease complicating hospital outcomes. These conditions are known to increase the risk of complications as measured by the Frailty Index (FI) and the Charlson Comorbidity Index.⁶ While providers may optimize these conditions for elective procedures, this luxury may not be possible during emergency situations when urinary catheters are generally required. Therefore, potentially modifiable risk factors will remain insufficiently treated by necessity of clinical urgency. The aim of this study is to define the incidence and risk factors, both modifiable and unmodifiable, for the development of hospital-acquired UTI in elderly, emergency surgical patients. We hypothesize that UTI rates will decrease after the implementation of the 2008 CMS regulations but that there will be significant ongoing rates of UTI with unmodifiable risk factors.

Methods

The American College of Surgeons National Surgical Quality Improvement Program (NSQIP) Participant Data File (PUF) was accessed to identify all elderly patients (age 65 and older) who were admitted to contributing institutions for an emergency abdominal operation between 2005 and 2012. The presence of UTI was determined based on the NSQIP definition, which uses one of two criteria developed within 30 days of the emergency operation or prior to hospital dismissal, whichever came first:

1. One or more symptoms (i.e. fever $>38^{\circ}\text{C}$, urgency, frequency, dysuria, suprapubic tenderness) IN ADDITION to a urine culture of 10^5 colony forming units per ml with no more than two species of organisms.

2. Two or more of the above symptoms IN ADDITION to one or more of the following:
 - a. urinalysis positive for leukocyte esterase and/or nitrates
 - b. >10 WBCs/cc or > 3 white blood cells per high power field of unspun urine
 - c. Organisms seen on Gram stain of unspun urine
 - d. Two urine cultures with repeated isolation of the same uropathogen with >10² colony forming units per ml urine in non-voided specimen
 - e. Urine culture with < 10⁵ colony forming units per ml urine of a single uropathogen in a patient being treated with appropriate antimicrobial therapy
 - f. Physician diagnosis
 - g. Physician institutes appropriate antimicrobial therapy

Additional UTI variables included the number of postoperative UTI occurrences within 30 days, preoperative evidence of UTI, and days from operation to UTI. Using the days from operation to UTI diagnosis and duration of postoperative hospital stay variables, we calculated whether the UTI developed in-hospital or after dismissal. Only in-hospital UTIs were included as the outcome of interest.

The demographic, clinical and procedural characteristics of patients who did and did not develop hospital acquired UTI were compared using chi-square tests for categorical variables and *t*-tests or rank sum tests for continuous variables. Multivariable logistic regression was utilized to determine independent factors associated with hospital acquired UTI development. A Cochran- Armitage test for trend was done to evaluate the rate of UTI over time.⁷ The alpha level was set at 0.05 for statistical significance. All analysis was conducted using SAS version 9.3 (SAS Institute Inc., Cary, NC).

Results

There were 53,879 elderly surgical patients (age ≥ 65 years) who underwent emergency abdominal operations in the NSQIP PUF between 2005 and 2012. Of these, 2482 (4.6%) developed a UTI within 30 days of operation including 1881 (3.58%) in-hospital and 601 (1.12%) post-discharge.

Numerous associated risk factors were identified on univariate analysis. In-hospital UTIs were observed more frequently in women and in patients who had the preoperative comorbidities of diabetes mellitus, partial or total dependent functional status, ventilator dependence, active pneumonia, history of congestive heart failure, history of myocardial infarction, and hypertension requiring medication (Table 1).

Hospital-acquired UTIs were more common in genitourinary, hepatobiliary (exclusive of cholecystectomy) and vascular surgery patients (Table 2). Rates were lowest in those receiving an appendectomy or cholecystectomy. Patients with an open operation had

significantly greater rates of UTI than those patients who underwent laparoscopic procedures (4.1% vs 1.0%, $p < 0.001$).

Rates of in-hospital UTI decreased during the study period from 6.6% in 2005 to 3.1% in 2012 ($p < 0.001$). The timing of the CMS decree was associated with a decrease in UTI rates as the rate went from 4.5% in 2005–2007 to 3.2% in 2008–2012 ($p < 0.001$). More specifically, the rate of UTI dropped from 4.6% in 2007 (the year preceding CMS implementation) to 3.7% in 2009 ($p = 0.006$).

In-hospital UTI was associated with an increased 30-day mortality (18.1% vs 15.5%, $p = 0.003$). Additionally, there was an association between duration of stay and risk of UTI; longer durations resulted in a greater chance for UTI development (Figure 1). Only 191 (0.35%) of the patients in the entire cohort had one of the three Current Procedural Terminology (CPT) codes associated with urinary catheter placement (51701, 51702, 51703); therefore, this variable was not considered in our analysis. After adjusting for patient and procedure characteristics, many features that were associated with

UTI on univariate comparisons were not independent risk factors upon multivariable regression (Table 3). Independent predictors of UTI that were identified included advanced age, female sex, insulin-dependent diabetes mellitus (IDDM), partial or total dependent functional status, preoperative open wound or wound infection, hypoalbuminemia, elevated ASA class, quadriplegia, preoperative sepsis, open operative approach, and prolonged operative time (all $p < 0.05$). Interestingly, preoperative leukocytosis, preoperative dialysis and contaminated surgical wounds were protective against UTI. Vascular ($p < 0.001$, OR=3.01, 95% CI 2.00–4.53), liver/pancreas ($p < 0.001$, OR=3.21, 95% CI 1.84–5.61), abdominal exploration ($p < 0.001$, OR=2.69, 95% CI 1.85–3.91), and hernia repair ($p = 0.001$, OR=1.97, 95% CI 1.31–2.95) procedures were the procedures which had the greatest independent association with UTI when compared to appendectomy. Of note, the post-CMS decree time period was independently associated with a decrease in UTI rates ($p < 0.001$, OR=0.80, 95% CI 0.70–0.90).

Discussion

The elimination of HAIs is a desired outcome that patients, physicians, and payers strive to achieve. Even under the best of circumstances, this is impossible. We can, however, strive for a severe reduction in HAI rates. With this aim in mind, CMS placed restrictions on monetary compensation to hospitals dealing with these complications. Unfortunately, utilization of urinary catheters is a necessity for most emergency surgical patients; up to 25% of patients admitted to acute care hospitals will receive an indwelling urinary catheter.⁸ This rate is even greater for elderly Medicare patients.⁹ Catheters are particularly difficult to avoid in emergency surgical patients who often undergo prolonged procedures, require careful urine output monitoring, and commonly develop postoperative urinary retention.¹³

This study demonstrated that, although UTI rates dropped in association with the CMS rule in 2008, a substantial UTI rate remained. Several risk factors predisposing elderly, emergency surgery patients to in-hospital UTI development were identified. Upon

qualitative analysis of these risk factors, three broad categories can be defined; unmodifiable (age, sex, quadriplegia, dialysis dependence, preoperative sepsis, type of operation), electively modifiable/emergently unmodifiable (hypoalbuminemia, diabetes mellitus, dependent functional status, ASA class, open wound at admission) and emergently modifiable (operative time, laparoscopic vs. open surgical approach).

Unmodifiable risk factors by definition cannot be improved. The age of a patient and their sex will never change to a lower risk classification. Therefore, the treating surgeon has no control to improve outcomes. Conversely, however, electively modifiable/emergently unmodifiable risk factors have the potential to improve and therefore decrease the rate of UTI acquired in the hospital. For instance, nutrition status can be improved by feeding tubes or total parenteral nutrition, functional status can be amended via physical therapy and one can obtain tighter glucose control for patients with diabetes mellitus. While these are potentially modifiable, time is needed for optimization. Time, however, is a luxury that emergency surgery patients do not possess. By its very nature, emergency surgery implies that the surgical procedure must be prioritized over other clinical parameters in order to prevent adverse outcomes such as death or significant morbidity. Therefore, these risk factors are unmodifiable for the acute care surgery patient. The results of this study can be used, however, to identify high risk patients with these unmodifiable factors and target them for early urinary catheter removal, screening urinalyses, and other interventions.

Emergently modifiable risk factors were identified, but the ability to significantly improve them is limited. For instance, the duration of a surgical procedure is, to a limited degree, influenced by the surgeon. Certainly, for critically ill patients, damage control procedures exist in order to expedite the duration of time spent in the operating room, but these patients are the minority and, by the very nature of their profound critical illness, have many of the other unmodifiable risk factors which supersedes the risk of operative duration. Rather, operations take as long as necessary to perform safely. As a risk factor for UTI development, operative duration is likely a surrogate for severity of illness, limited post-operative mobility, and therefore the need for prolonged urinary catheter utilization.¹⁰ Another potentially modifiable risk factor is the operative approach chosen by the surgeon. Colectomy, appendectomy, and cholecystectomy procedures, when successfully performed laparoscopically, had a lower rate of post-operative UTI than their open counterparts. This is likely due to decreased pain, enhanced mobility and earlier return to normal activity resulting in less need for urinary catheterization.¹¹ While it may be nice to think that by increasing the rate of laparoscopic procedures the rate of UTI will be diminished, an open approach tends to be a surrogate for operative difficulty and therefore the complexity of the disease process rather than surgeon preference.¹² Instead, the very nature of the procedure that makes it an emergency also dictates the operative approach. For instance, a greater Boey score, advanced age and prolonged duration of symptoms are all considered contraindications for laparoscopic repair of perforated peptic ulcer disease.¹¹ Nevertheless, it is worth considering the least invasive technique which will successfully treat the patient's pathology.

While the ACS-NSQIP PUF is one of the more detailed datasets available, there are significant limitations to our study. The database does not include data on the duration of

urinary catheterization; thus, only surrogates such as duration of hospital stay and open versus laparoscopic approaches can be evaluated. We were unable to include the urinary catheter CPT codes in the analysis as we suspect it was grossly under-reported.⁸ As a result, we were unable to distinguish between CAUTI and UTI. As prolonged catheterization is known to be the primary risk factor for UTI development, we suspect strongly that the majority of the UTIs were truly CAUTI. This, however, remains a significant limitation to our study. In fact, we believe that the NSQIP definition of UTI should be altered to include CAUTI criteria. Furthermore, we maintain that NSQIP should mandate the collection of urinary catheter duration in order to further define the risk factors of UTI development. Another study limitation includes the lack of routine urinalysis, urine culture and a history of UTI symptoms on admission in emergency surgical patients. In fact, their overlying symptoms requiring operative intervention will likely mask UTI-associated symptoms. Therefore, emergency surgery patients may present with undetected, asymptomatic bacteriuria which blossoms into a UTI after urinary catheter placement. Even if not present on admission, emergency surgery patients are likely at a higher risk for UTI than medical patients. For instance, trauma patients are predisposed to UTIs due to a transient, acquired immunosuppression and alteration of urine composition favoring bacteria growth with elevated levels of catecholamines, glucose, iron, and amino acids.³ In addition, the ACS NSQIP does not collect data regarding perioperative antibiotic utilization. We suspect that the lower rates of UTI in patients with leukocytosis and dirty/infected wounds are due to a more aggressive antibiotic regimen. Lastly, due to de-identification of the dataset for privacy reasons, only year, and not month, of surgery is provided. Therefore, when examining the impact of CMS reimbursement policy change effective October 1, 2008, we were limited to comparing 2007 and earlier to 2008 onwards. Given the pre-warning of the new CMS policy, hospitals had to prepare for the edict months in advance making a January comparison logical.

Vigilance must be maintained by acute care surgeons to ensure timely and appropriate removal of urinary catheters. Not only does each day of catheterization increase the rate of bacteriuria by 5%, but each UTI costs at least an additional, unreimbursed \$600.^{13,14} With millions of patients undergoing catheterization each year, this can be a costly complication to develop.² With early diagnosis, timely catheter removal, research into the urinary microbiome and development of new technologies impeding the development of UTI, this complication can be reduced further. While hospital-acquired UTI may be “reasonably preventable,” they are not 100% avoidable with current technology in the setting of multiple unmodifiable risk factors. Therefore, the global elimination of reimbursement for hospital acquired UTI is neither reasonable nor sustainable.

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Appendix 1. ICD-9-CM Diagnosis Codes Included in Study

11008,22999,34151,34502,34830,34831,34832,34833,35081,35082,35091,35092,35102,35103,35111,35112,35121,35122,35131,35132,35221,35331,35341,35351,35355,35363,35371,35531,35537,35538,35539,35540,35548,35549,35551,35565,35631,35633,35634,35637,35638,35641,35646,35647,35650,35651,35663,35665,35840,35907,37617,37660,38100,38101,38102,38115,38120,38564,38570,39501,39502,39520,39530,39531,39541,39561,39599,43107,43112,43113,43117,43118,43122,43124,43279,43280,43281,43282,43289,43300,43310,43312,43320,43324,43325,43326,43327,43330,43331,43332,43333,43335,43340,43352,43360,43361,43400,43405,43410,43415,43420,43425,43496,43500,43501,43502,43510,43520,43605,43610,43611,43620,43621,43622,43631,43632,43633,43634,43635,43640,43641,43644,43645,43659,43770,43771,43772,43774,43775,43800,43810,43820,43825,43832,43840,43843,43845,43846,43848,43850,43860,43865,43870,43880,43886,43887,43999,44005,44010,44020,44021,44025,44050,44055,44110,44111,44120,44121,44125,44126,44127,44128,44130,44139,44140,44141,44143,44144,44145,44146,44147,44150,44151,44152,44153,44155,44156,44157,44158,44160,44180,44187,44188,44200,44202,44203,44204,44205,44206,44207,44208,44210,44211,44212,44213,44227,44238,44310,44312,44314,44316,44320,44322,44340,44345,44346,44602,44603,44604,44605,44615,44620,44625,44626,44640,44650,44660,44661,44680,44700,44799,44800,44820,44850,44899,44900,44950,44955,44960,44970,44979,45000,45005,45020,45108,45110,45111,45112,45113,45114,45116,45123,45126,45130,45135,45136,45395,45402,45550,45562,45563,45805,47010,47015,47120,47122,47125,47130,47350,47360,47361,47362,47370,47379,47380,47382,47399,47400,47420,47425,47460,47480,47490,47550,47560,47562,47563,47564,47579,47600,47605,47610,47612,47620,47630,7720,47721,47740,47741,47760,47780,47785,47900,47999,48000,48001,48005,48100,48105,48120,48140,48145,48146,48150,48152,48153,48154,48155,48160,48500,48510,48511,48520,48540,48545,48547,48548,48999,49000,49002,49010,49020,49021,49040,49060,49062,49080,49081,49085,49200,49201,49203,49204,49205,49250,49255,49321,49322,49323,49324,49325,49329,49402,49418,49421,49422,49425,49560,49561,49565,49566,49568,49570,49572,49580,49582,49585,49587,49590,49652,49653,49654,49655,49656,49657,49659,49900,49904,49905,49906,49999,50010,50020,50130,50205,50220,50225,50230,50234,50236,50240,50542,50543,50544,50545,50546,50548,50727,50728,50780,50785,50810,50820,50825,50900,50947,51020,51040,51045,51050,51065,51080,51530,51550,51555,51565,51570,51590,51595,51597,51800,51860,51865,51880,51920,57305,57307,57308,57423,58150,58152,58180,58200,58542,58552,58700,58720,58740,58925,58940,58943,58950,58952,58953,58960,59120,60540,60545,60600,60650

References

1. Kleven RM, Edward JR, et al. Estimating health care-associated infections and deaths in U.S. hospitals, 2002. Public Health Reports. 2007; 122:160–166. [PubMed: 17357358]
2. Saint S, Meddings JA, Calfee D, Kowalski CP, Krein SL. Catheter-associated urinary tract infection and the Medicare rule changes. Ann Intern Med. Jun 16; 2009 150(12):877–84. [PubMed: 19528567]
3. Aubron C, Huet O, et al. Changes in urine composition after trauma facilitates bacterial growth. BMC Infect Dis. Nov 29.2012 12(1):330. [PubMed: 23194649]
4. Haley RW, Culver DH, White JW, Morgan WM, Emori TG. The nationwide nosocomial infection rate. A new need for vital statistics. Am J Epidemiol. 1985; 121(2):159–67. PubMed: 4014113. [PubMed: 4014113]
5. Scott, RD. [accessed November 13, 2013] The Direct Medical Costs of Healthcare-Associated Infections in U.S.. Hospitals and the Benefits of Prevention. http://www.cdc.gov/HAI/pdfs/hai/Scott_CostPaper.pdf
6. Melzer M, Welch C. Outcomes in UK patients with hospital-acquired bacteraemia and the risk of catheter-associated urinary tract infections. Postgrad Med J. Jun; 2013 89(1052):329–34. doi: 10.1136/postgradmedj-2012-131393. Epub 2013 Mar 21. [PubMed: 23520064]
7. Agresti, A. Categorical Data Analysis. John Wiley & Sons; New York: 1990.
8. Saint S. Clinical and economic consequences of nosocomial catheter-related bacteriuria. Am J Infect Control. 2000; 28(1):68–75. PubMed: 10679141. [PubMed: 10679141]
9. Medicare program; changes to the hospital inpatient prospective payment systems and fiscal year 2008 rates. Fed Regist. 2007; 72(162):47129–8175. PubMed: 17847578. [PubMed: 17847578]
10. Gray A. United Kingdom national confidential enquiry into perioperative deaths. Minerva Anesthesiol. 2000; 66(5):288–292. [PubMed: 10965704]
11. Navez B, Navez J. Laparoscopy in the acute abdomen. Best Pract Res Clin Gastroenterol. Feb; 2014 28(1):3–17. doi: 10.1016/j.bpg.2013.11.006. Epub 2013 Dec 4. [PubMed: 24485251]

12. Bertleff MJ, Lange JF. Laparoscopic correction of perforated peptic ulcer: first choice? A review of literature. *Surg Endosc*. Jun; 2010 24(6):1231–9. doi: 10.1007/s00464-009-0765-z. Epub 2009 Dec 24. [PubMed: 20033725]
13. Elpern EH, Killeen K, Ketchum A, Wiley A, Patel G, Lateef O. Reducing use of indwelling urinary catheters and associated urinary tract infections. *Am J Crit Care*. Nov; 2009 18(6):535–41. quiz 542. doi: 10.4037/ajcc2009938. [PubMed: 19880955]
14. Maki DG, Tambyah PA. Engineering out the risk for infection with urinary catheters. *Emerging Infectious Diseases*. 2001; 7(2):342–7. PubMed: 11294737. [PubMed: 11294737]

Figure 1.
Hospital-acquired Urinary Tract Infections by Hospital Length of Stay

Figure 2.

Rates of Urinary Tract Infection per year. UTI = urinary tract infection;
CMS = Center for Medicare and Medicaid Services

Table 1

Univariate analysis of demographic, preoperative, operative, and postoperative risk factors for urinary tract infection.

<i>N</i> = 53879		Missing data	No UTI (<i>n</i> =51998)	UTI (<i>n</i> =1881)	P value
Demographic and preoperative clinical factors					
Age, mean (SD) (years)		-	76.2 (7.5)	77.5 (7.4)	<.001
Female gender		109	28565 (55.0)	1211 (64.5)	<.001
BMI, mean (SD)		4994	27.3 (6.9)	27.63 (7.6)	.32
Laparoscopic approach		-	10437 (20.1)	102 (5.4)	<.001
Diabetes Mellitus	No		41616 (80.0)	1402 (74.5)	
	NIDDM	-	6371 (12.3)	258 (13.7)	<.001
	IDDM		4011 (7.7)	221 (11.7)	
Functionally dependent, partial or total		268	13380 (25.9)	784 (41.9)	<.001
Ventilator dependent		-	4134 (8.0)	242 (12.9)	<.001
Pneumonia		11312	1577 (3.8)	96 (6.3)	<.001
Congestive Heart Failure		-	2318 (4.5)	130 (6.9)	<.001
Myocardial Infarction within 6 months		11311	1197 (2.9)	71 (4.6)	<.001
Hypertension requiring medication		-	36916 (71.0)	1431 (76.1)	<.001
Acute renal failure		-	2030 (3.9)	118 (6.3)	<.001
Impaired sensorium		11311	2800 (6.8)	175 (11.4)	<.001
Stroke with or without neurologic deficit		11312	3935 (9.6)	208 (13.6)	<.001
Paraplegia		11311	200 (0.5)	17 (1.1)	<.001
Quadriplegia		11311	71 (0.2)	10 (0.7)	<.001
Open or infected wound		-	3151 (6.1)	199 (10.6)	<.001
Corticosteroids		-	3849 (7.4)	188 (10.0)	<.001
Preoperative transfusion >4 pRBCs within 72 hours		-	3069 (5.9)	172 (9.1)	<.001
Systemic sepsis		161	23970 (46.2)	1018 (54.2)	<.001
Prior operation within 30 days		13459	3688 (9.5)	196 (13.8)	<.001
Creatinine 1.2		1256	20419 (40.2)	827 (45.2)	<.001
Albumin <3.5		11426	21737 (53.1)	1017 (66.3)	<.001

N = 53879		Missing data	No UTI (n=51998)	UTI (n=1881)	P value
Operative and postoperative * factors					
Wound classification	Clean		7846 (15.1)	303 (16.1)	<.001
	Clean/Contaminated		16380 (31.5)	708 (37.6)	
	Contaminated		10776 (20.7)	349 (18.6)	
	Dirty/Infected		16996 (32.7)	521 (27.7)	
ASA class	1–2	77	10085 (19.4)	135 (7.2)	<.001
	3		41837 (80.6)	1745 (92.8)	
Red blood cell transfusion †		27593	5063 (20.0)	340 (33.1)	<.001
Operative time	<60 minutes	30	14874 (28.6)	371 (19.7)	<.001
	60–119 minutes		21849 (42.0)	750 (39.9)	
	120–179 minutes		9369 (18.0)	430 (22.9)	
	180 minutes		5879 (11.3)	327 (17.4)	
Length of stay, mean (SD) (days)		-	12.7 (14.9)	27.3 (22.7)	<.001
Wound disruption		-	1040 (2.0)	62 (3.3)	<.001
Pneumonia		8	4322 (8.3)	341 (18.2)	<.001
>48 hours mechanical ventilation		1	8913 (17.1)	691 (36.8)	<.001
Progressive renal insufficiency		1	774 (1.5)	49 (2.6)	<.001
Acute renal failure		1	1688 (3.2)	84 (4.5)	.004
Stroke		-	429 (0.8)	26 (1.4)	.009
Bleeding transfusions ‡	2005–2009		605 (2.4)	42 (4.1)	<.001
	2010	14	5971 (22.3)	265 (31.5)	
Sepsis/Septic shock		4	6939 (13.3)	604 (32.2)	<.001
Return to operating room		1	5401 (10.4)	400 (21.3)	<.001
Readmission ¶		45748	898 (11.4)	19 (6.9)	.021

Values are presented as mean ± s.d. or n (%).

UTI = urinary tract infection; IDDM = insulin dependent diabetes mellitus; NIDDM = non-insulin dependent diabetes mellitus; pRBC = packed red blood cells; ASA = American Society of Anesthesiologists.

* Postoperative factors include complications that occurred prior to UTI only.

§ Red blood cell transfusion indicates 1 units in the postoperative period.

‡ Documentation of the bleeding/transfusion complication in NSQIP was altered in 2010.

¶ Readmission information is only available for the 2011 NSQIP data.

Table 2

Rates of urinary tract infection per organ undergoing operation

Organ(s)	All (N = 53879)	No UTT	UTI
Colon	17734	16991 (95.8)	743 (4.2)
Small Bowel	9774	9334 (95.5)	440 (4.5)
Appendix	7189	7146 (99.4)	43 (0.6)
Gallbladder	4507	4448 (98.7)	59 (1.3)
Abdominal Exploration	3450	3295 (95.5)	155 (4.5)
Hernia	3166	3080 (97.3)	86 (2.7)
Vascular	2999	2843 (94.8)	156 (5.2)
Stomach	2910	2807 (96.5)	103 (3.5)
Other Abdominal	789	750 (95.1)	39 (4.9)
Liver and Pancreas	390	369 (94.6)	21 (5.4)
Esophagus	320	311 (97.2)	9 (2.8)
Spleen	266	259 (97.4)	7 (2.6)
Genitourinary	217	205 (94.5)	12 (5.5)
Rectal	168	160 (95.2)	8 (4.8)

UTI = urinary tract infection

Table 3

Multivariable analysis*: Risk factors for in-hospital UTI

Feature		p value	OR	95% CI
Age (vs 65–69)	70–79	0.002	1.23	1.08–1.40
	80–89	<0.01	1.33	1.15–1.53
	90+	0.017	1.31	1.05–1.64
Post-CMS UTI Decree (2009+)		<0.01	0.80	0.70–0.90
Female sex (vs. male)		<0.01	1.52	1.37–1.68
Open procedure (vs. laparoscopic)		<0.01	1.93	1.53–2.43
Insulin-dependent diabetes mellitus (vs non-diabetic)		<0.01	1.32	1.13–1.54
Dependent functional status (vs. independent)		<0.01	1.34	1.20–1.49
Current smoker (vs. never)		0.35	1.07	0.93–1.23
Ventilator dependence		0.68	0.97	0.82–1.14
Preoperative pneumonia		0.50	1.08	0.86–1.36
Congestive heart failure within 30 days		0.77	1.03	0.85–1.25
Myocardial infarction within 6 months		0.48	1.10	0.85–1.41
Hypertension requiring medication		0.22	1.07	0.96–1.20
Preoperative acute renal failure		0.11	1.18	0.96–1.45
Preoperative dialysis		0.003	0.67	0.52–0.87
Impaired sensorium		0.34	1.09	0.92–1.30
History of stroke		0.10	1.14	0.98–1.33
Paraplegia		0.08	1.58	0.95–2.63
Quadriplegia		0.006	2.60	1.31–5.14
Pre-existing Open Wound/Wound Infection		0.015	1.22	1.04–1.44
Corticosteroids for chronic condition		0.13	1.13	0.96–1.32
Transfused >4 pRBCs within 72 hours of surgery		0.14	1.14	0.96–1.36
Preoperative systemic sepsis		0.001	1.20	1.07–1.34
Preoperative serum creatinine 1.2		0.97	1.00	0.90–1.11
Preoperative albumin < 3.5 g/dL		0.002	1.20	1.07–1.35
Preoperative white blood cell count 11.6		0.039	0.90	0.81–0.99
Wound classification (vs clean)	Clean/contaminated	0.010	1.25	1.05–1.49
	Contaminated	0.73	1.04	0.85–1.26
	Dirty/infected	0.031	0.81	0.67–0.98
ASA class III (vs class I–II)		<0.001	1.61	1.33–1.94
Operative time (vs <60 minutes)	60–119 minutes	0.07	1.13	0.99–1.29
	120–179 minutes	<0.001	1.34	1.15–1.57
	180 minutes	<0.001	1.56	1.32–1.84

OR = Odds ratio; CI = Confidence Interval; pRBC = packed red blood cells; ASA = American Society of Anesthesiologists.

* Adjusted for 30 total patient and procedure variables. Unlisted variables include year of procedure, BMI, and procedure group.