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Postoperative Urinary Tract Infection and Short-Term Outcomes and Costs in Head and Neck Cancer Surgery

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Abstract

Objectives. Catheter-associated urinary tract infections (UTIs) have been identified as a preventable "never event" by the Centers for Medicare & Medicaid Services. We sought to determine the relationship between UTI and in-hospital mortality, postoperative complications, length of stay, and costs in head and neck cancer (HNCA) surgery.

Study Design. Cross-sectional analysis using cross-tabulations and multivariate regression modeling.

Setting. The Nationwide Inpatient Sample database.

Subjects and Methods. Discharge data for 93,663 patients who underwent an ablative procedure for a malignant oral cavity, laryngeal, hypopharyngeal, or oropharyngeal neoplasm in 2003-2008 were analyzed.

Results. Urinary tract infection was diagnosed in 2% of patients, with catheter-associated UTI coded in only 20 patients. Patients with UTI were more likely to be older than 80 years (odds ratio [OR], 3.3; $P = .008$), be female (OR, 1.9; $P < .001$), have advanced comorbidity (OR, 1.8; $P < .012$), undergo major surgical procedures (OR, 1.7; $P = .001$), and have predisposing bladder and prostate conditions (OR, 3.8; $P < .001$), surgical complications (OR, 2.3; $P < .001$), and acute medical complications (OR, 3.1; $P < .001$). Urinary tract infection was associated with significantly increased length of hospitalization and hospital-related costs, after controlling for all other variables.

Conclusion. Urinary tract infection is unusual in HNCA surgical patients but is more common with extent of surgery and age and is significantly associated with postoperative complications, length of hospitalization, and hospital-related costs. Catheter-associated UTI is likely underestimated because of difficulty in distinguishing between a catheter-associated UTI and postoperative UTI in patients undergoing major surgical procedures, who routinely undergo perioperative urinary catheterization. Patients with HNCA are a high-risk group for this "never event," particularly as the population ages.

Keywords

urinary tract infection, urinary catheter, head and neck neoplasms, complications, surgery, Nationwide Inpatient Sample

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Urinary tract infection (UTI) is the most common acquired nosocomial infection in the United States, accounting for more than 30% of hospital-acquired infections.[1,2] These health care–associated UTIs are primarily related to instrumentation of the urinary tract, with urinary catheter insertion responsible for 80% of cases,[3] and are associated with significant morbidity, mortality, and costs.[1] On October 1, 2008, the Centers for Medicare & Medicaid Services (CMS) began withholding reimbursement payments to pay for the cost of treating catheter-associated UTIs, which CMS considered a ''reasonably preventable'' hospital-acquired condition through the use of evidence-based guidelines. According to the Centers for Disease Control and Prevention, catheter-associated UTIs are defined as a UTI occurring in a patient who has a urinary catheter in place within 48 hours of the onset of infection, with no minimum period of time that a catheter must be in place for a UTI to be considered catheter associated.[4]

The risk of catheter-associated UTI has been shown to be reduced by limiting use of catheters, early catheter removal, aseptic placement techniques, and use of closed drainage systems, with emerging evidence supporting a potential benefit for antimicrobial or bacteriostatic silver alloy catheter placement.[3,5] The use of prevention guidelines has been shown to reduce the incidence of catheter-associated UTI by more than 50%.[2] However, perioperative urinary catheterization is common in patients undergoing major surgical procedures and nearly

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universal in older surgical patients who frequently have comorbid conditions that justify chronic indwelling catheterization, such as urinary retention, bladder outlet obstruction, and prostate disease, who are at increased risk of UTI.[6] Head and neck cancer (HNCA) surgical patients may be at increased risk for catheter-associated UTI, as many of the variables associated with an increased risk of this event are common in this population, who are typically older, male, with comorbid illness, and often undergo complex surgical procedures. We sought to determine the relationship between UTI and in-hospital mortality, postoperative complications, length of stay, and costs in patients undergoing HNCA surgery using a national hospital discharge database.

Methods

A cross-sectional analysis of patients with a diagnosis of oral cavity, laryngeal, hypopharyngeal, or oropharyngeal cancer was performed using discharge data from the Nationwide Inpatient Sample (NIS), Healthcare Cost and Utilization Project (HCUP), Agency for Healthcare Research and Quality (AHRQ). The NIS is the largest all-payer inpatient care database in the United States, containing data from approximately 8 million hospital stays each year from a stratified sample of 20% of nonfederal US hospitals from participating states.[7] The NIS database provides information regarding the index hospital admission and includes patient demographic data, primary and secondary diagnoses, primary and secondary procedures, hospital characteristics, and inpatient and discharge mortality rates. The *International Classification of Disease, Ninth Revision* (*ICD-9*) codes were used to identify adult patients ($\geq$18 years of age) who underwent an ablative procedure for a malignant oral cavity, laryngeal, hypopharyngeal, or oropharyngeal neoplasm from 2003 to 2008 (**Table 1**). Oropharyngeal cancer patients undergoing biopsy were included if neck dissection was the index admission procedure and no other ablative procedure was recorded. Reconstructive procedures were obtained from codes for pedicled or free flap reconstruction (**Table 1**). Prior irradiation was obtained from the codes for previous exposure to therapeutic or other ionizing radiation (V15.3). Urinary catheter placement was obtained using codes for insertion or reinsertion of an indwelling urinary catheter (57.94, 57.95).

Comorbidity was graded using the Romano adaptation of the Charlson comorbidity index,[8-10] excluding *ICD-9* codes for the index cancer diagnosis from the solid tumor category. Cancer staging information is not available in the NIS, and as a result, *ICD-9* codes for metastases were excluded as these have not been shown to be a reliable surrogate for disease stage.[11] Codes for specific comorbid illnesses were used to create categories for acute medical and surgical complications, with additional categories created for conditions predisposing to the development of UTI (**Table 2**). Acute medical complications were derived from codes for acute cardiac events, acute pulmonary edema or failure, acute renal failure, acute hepatic failure, acute cerebrovascular events, sepsis, pneumonia, and UTI assigned at the time of hospital discharge, and surgical complications were derived from codes for complications directly resulting from surgical procedures assigned at the time of hospital discharge.

In-hospital death, complications, length of hospitalization, and costs were examined as dependent variables. Independent variables included were age, sex, race, payer source (commercial or health maintenance organization [HMO], Medicare, Medicaid, self-pay, or other), procedure, comorbidity, nature of admission (emergent/urgent or other), predisposing conditions, and UTI. Procedures were categorized by severity as minor (excision/destruction of lesion, tonsillectomy, and partial glossectomy, with or without neck dissection, and neck dissection alone when performed as the index admission procedure) and major (partial or total laryngectomy, esophagectomy, total glossectomy, pharyngectomy, mandibulectomy, and maxillectomy, with or without neck dissection). American Joint Commission on Cancer (AJCC) tumor stage, tumor grade, histological subtype, and outcome after discharge were not available from the NIS database.

Hospital-related charges for each index admission were converted to the organizational cost of providing care using cost-to-charge ratios for individual hospitals. Cost-to-charge ratios were calculated using information from the detailed reports by hospitals to the CMS, providing an estimate of the all-payer inpatient cost-to-charge ratio by hospital.[12] This ratio was multiplied by each patient's charge to obtain the cost per admission.[13] All costs were adjusted for inflation based on US Bureau of Labor Statistics indices, with results converted to 2012 US dollars.[14] To obtain national cost estimates, all discharges were reweighted to account for cases where cost estimates were missing.[12]

Data were analyzed using Stata 12 (StataCorp, College Station, Texas). Associations between variables were analyzed using cross-tabulations, multivariate logistic regression, and multinomial logistic regression modeling. Nonzero discharge counts with fewer than 10 observations were masked in accordance with the HCUP data use agreement. Data were weighted, and modified hospital and discharge weights to correct for changes in sampling over time were applied. Variance estimation was performed using procedures for survey data analysis with replacement. Strata with 1 sampling unit were centered at the population mean. Variables with missing data for more than 10% of the population were coded with a dummy variable to represent the missing data in regression analysis. The primary clinical end points were evaluated using multiple logistic regression analysis. Generalized linear regression modeling with a log link was used to analyze costs and length of stay because these variables were not normally distributed. This protocol was reviewed and approved by the Johns Hopkins Medical Institutions Institutional Review Board.

Results

There were 93,663 cases in 2003-2008 (**Table 3**). Because there were only 20 cases coded as having a catheter-associated UTI, catheter-associated UTI was combined with UTI for analysis. Only 1744 cases (2%) were diagnosed

Table 1. *ICD-9* Diagnosis and Procedure Codes for Included Cases

Variable	*ICD-9* Code
Diagnosis codes	
Neoplasms	
Laryngeal neoplasm (malignant)	161.0, 161.1, 161.2, 161.3, 161.8, 161.9, 146.4, 146.5
Hypopharyngeal neoplasm (malignant)	148.0, 148.1, 148.2, 148.3, 148.8, 148.9
Oral cavity neoplasm (malignant)	140.0, 140.1, 140.3, 140.4, 140.6, 140.8, 140.9, 141.1, 141.2, 141.3, 141.4, 141.9, 143.0, 143.1, 143.8, 143.9, 144.0, 144.4, 144.8, 144.9, 145.0, 145.1, 145.2, 145.5, 145.6, 145.8, 145.9, 170.1
Oropharyngeal neoplasm (malignant)	141.0, 141.5, 141.6, 141.8, 145.3, 145.4, 146.0, 146.1, 146.2, 146.3, 146.6, 146.7, 146.8, 146.9, 149.0, 149.1
Procedure codes	
Laryngeal cancer procedures	
Excision/destruction of lesion	30.09
Partial laryngectomy	30.1, 30.21, 30.29
Total laryngectomy/laryngopharyngectomy	30.3, 30.4
Esophagectomy	42.40, 42.41, 42.42
Hypopharyngeal cancer procedures	
Excision/destruction of lesion	29.39, 30.09
Partial laryngectomy	30.1, 30.29
Total laryngectomy/laryngopharyngectomy	30.3, 30.4
Pharyngectomy	29.33
Esophagectomy	42.40, 42.41, 42.42
Oral cavity cancer procedures	
Excision/destruction of lesion	25.1, 27.3, 27.31, 27.4, 27.42, 27.43, 27.49
Partial glossectomy	25.2
Total glossectomy	25.3, 25.4
Maxillectomy	27.32
Mandibulectomy	76.31, 76.41, 76.42
Oropharyngeal cancer procedures	
Excision/destruction of lesion	25.1, 27.72, 27.79, 28.5, 28.91, 29.39
Tonsillectomy	28.2
Partial glossectomy	25.2
Total glossectomy	25.3, 25.4
Pharyngectomy	29.33
Mandibulectomy	76.31, 76.41, 76.42
Non–site-specific procedures	
Neck dissection	40.40, 40.41, 40.42, 40.3
Pedicled or free flap reconstruction	86.7, 86.70, 86.71, 86.72, 86.73, 86.74, 86.75, 86.8, 86.89

Abbreviation: *ICD-9, International Classification of Disease, Ninth Revision*.

with a UTI. Urinary catheter placement was only recorded in 404 patients (0.4%). The majority of patients were male and white, with a mean age of 62.0 years (range, 18-104 years). Patients who developed a UTI were more likely to be female; be ≥65 years of age; have advanced comorbidity; be admitted urgently or emergently; undergo major surgical procedures; have predisposing conditions for UTI; have acute cardiac, pulmonary, infectious, or surgical complications; and require medical care at another facility or at home after discharge.

Multiple logistic regression analysis of variables known at the time of admission that were significantly associated with the risk of developing a UTI is shown in **Table 4**. A diagnosis of UTI was significantly associated with urgent or emergent admission, age older than 80 years, female sex, Medicaid payor status, major surgical procedures, comorbidity, and predisposing medical conditions for UTI, after controlling for all other variables. The small number of patients with catheter-associated UTI precluded separate analysis.

Multiple logistic regression analysis of independent variables associated with the risk of in-hospital death and postoperative complications is shown in **Table 5**. After controlling for the effects of all variables, the only statistically and independently significant factors associated

Table 2. *ICD-9* Diagnosis Codes for Comorbid Conditions

Variable	*ICD-9* Code
Predisposing conditions	
Benign prostatic hypertrophy	600.00, 600.01, 600.11
Urinary incontinence (physiologic)	788.30-788.39
Incomplete bladder emptying	788.21
Urinary obstruction	599.69
Retention of urine	788.20-788.29
Oliguria	788.5
Urinary frequency	788.41
Polyuria	788.42
Nocturia	788.43
Intermittent urinary stream	788.61
Straining on urination	788.65
Urinary hesitancy	788.64
Urinary urgency	788.63
Weak urinary stream	788.62
Neurogenic bladder	344.61, 596.4, 596.53, 596.54
Paralysis	342.0-344.9, 438.20-438.53, 780.72
Urinary incontinence (functional)	788.91
Acute complications	
Surgical complications	
Shock	998.0
Hemorrhage, hematoma, or seroma	998.1, 998.11, 998.12, 998.13
Accidental perforation or laceration of blood vessel, nerve, or organ	998.2
Wound dehiscence	998.3, 998.30, 998.31, 998.32, 998.33
Foreign body	998.4
Postoperative infection	998.5, 998.51, 998.59
Postoperative fistula	998.6
Nonhealing surgical wound	998.83
Other unspecified procedural complications	998.8, 998.81, 998.89, 998.9
Medical complications	
Acute cardiac event	410.0-410.9, 411.1, 411.8, 415.0, 420.0, 420.9, 421.0, 421.1, 421.9, 422.0, 422.9, 427.0-427.5, 428.0-428.9
Acute pulmonary edema/failure	518.4, 518.81, 518.82, 518.84
Acute cerebrovascular event	997.00, 997.01, 997.02, 997.09
Acute renal failure	584.5-584.9
Acute hepatic failure	570
Pneumonia	480,480.0, 480.1, 480.2, 480.3, 480.8, 480.9, 481, 482, 482.0, 482.1, 482.3, 482.30, 482.31, 482.32, 482.39, 482.40, 482.41, 482.42, 482.49, 482.8, 482.81, 482,82, 482.83, 482.84, 482.89, 482.9, 483, 483.1, 483.8, 484, 484.1, 484.3, 484.5, 484.6, 484.7, 484.8, 485, 487.0, V12.61, 507.0, 514, 518.4, 518.5, 516, 516.8, 997.31
Sepsis	995.9, 038.0-038.4, 999.3
Urinary tract infection	599.0, 996.64, 996.31, V13.02

Abbreviation: *ICD-9, International Classification of Disease, Ninth Revision.*

with the risk of in-hospital death were urgent or emergent admission, age >80 years, Medicare or Medicaid status, advanced comorbidity, major surgical procedures, and pedicled or free flap reconstruction. The development of a UTI was not associated with an increased risk of in-hospital death. Postoperative surgical complications were significantly associated with urgent/emergent admission, Medicaid payor status, major procedures, flap reconstruction, neck dissection, and comorbidity, whereas acute medical complications were associated with urgent or emergent admission, age 65 years

Table 3. Demographic Characteristics

	All Patients (n = 93,663), %	No UTI (n = 91,919), %	UTI (n = 1744), %	*P* Value
Primary site				.0005
Oral cavity	39.0	39.0	43.4	
Larynx	26.5	26.4	33.0	
Hypopharynx	3.5	3.5	2.1	
Oropharynx	31.0	31.2	21.5	
Age group, y				<.0001
≤40	4.0	4.0	2.0	
40-64	53.9	54.3	32.4	
65-80	34.0	33.7	47.5	
>80	8.2	8.1	18.2	
Race				.5758
White	61.3	61.3	60.2	
Black	6.4	6.4	8.8	
Hispanic	4.4	4.5	4.2	
Asian or Pacific Islander	1.6	1.6	0.9	
Native American	0.3	0	—[a]	
Other	1.9	1.9	2.1	
Unknown	24.1	24.1	23.2	
Sex				<.0001
Male	69.6	69.9	56.9	
Female	30.4	30.2	43.1	
Payor				<.0001
Private	40.2	40.6	20.9	
Medicare	42.4	42.1	62.0	
Medicaid	10.3	10.3	13.2	
Self-pay	3.7	3.7	1.8	
No charge	0.5	0.5	—[a]	
Other	2.8	2.8	1.8	
Nature of admission				<.0001
Elective	84.3	84.5	73.4	
Emergency/urgent	15.7	15.5	26.6	
Comorbidity				<.0001
0	61.7	62.0	44.4	
1	26.2	26.0	32.1	
2	8.5	8.4	16.4	
≥3	3.7	3.6	7.1	
Procedure severity				
Minor	48.7	49.0	35.7	<.0001
Major	51.3	51.0	64.3	
Flap	9.8	9.7	13.2	.0500
Comorbid illness				
Predisposing conditions	5.9	5.0	18.4	<.0001
Catheter	0.4	0.4	0.8	.2268
Acute comorbidity				
Acute cardiac event	9.8	9.6	21.4	<.0001
Acute pulmonary edema/failure	3.8	3.6	9.7	<.0001
Acute cerebrovascular event	0.4	0.4	0	.6284
Acute renal failure	1.2	1.1	5.9	<.0001
Acute hepatic failure	<0.1	0	—[a]	.7880
Pneumonia	0.9	6.1	25.4	<.0001
Sepsis	1.9	0.8	6.7	<.0001
Surgical complications	10.7	10.5	23.3	<.0001

(continued)

Table 3. (continued)

	All Patients (n = 93,663), %	No UTI (n = 91,919), %	UTI (n = 1744), %	*P* Value
Disposition				<.0001
Routine	58.3	58.9	25.8	
Short-term hospital care	0.8	0.7	2.6	
Other facility	10.4	9.9	36.7	
Home health care	29.5	29.4	32.9	
AMA	0.1	0.1	0	
Died in hospital	0.9	0.9	2.1	

Abbreviations: AMA, against medical advice; UTI, urinary tract infection.
[a]Less than 11 observations.

Table 4. Multivariate Logistic Regression Analysis of Variables Predictive of UTI

Variable	Odds Ratio	95% CI	*P* Value
Urgent/emergent admission	1.92	1.44-2.56	<.001
Age >80 y	3.27	1.35-7.91	.008
Female	1.88	1.46-2.41	<.001
Major procedure	1.67	1.24-2.25	.001
Medicaid	2.08	1.27-3.40	.004
Comorbidity score 1	1.32	1.01-1.72	.040
Comorbidity score 2	1.87	1.33-2.63	<.001
Comorbidity score ≥3	1.78	1.14-2.81	.012
Predisposing conditions	3.75	2.78-5.06	<.001

Abbreviations: CI, confidence interval; UTI, urinary tract infection.

or older, Medicare or Medicaid payor status, pedicled or free flap reconstruction, major surgical procedures, and comorbidity. Both postoperative surgical complications and acute medical complications were significantly associated with UTI.

Multivariate generalized linear regression analyses of independent variables predictive of length of hospital stay and hospital-related costs are shown in **Table 6**, with mean values representing the change in the value of the intercept mean. After controlling for all other variables, urgent or emergent admission; Medicare, Medicaid, and self-pay payor status; comorbidity; neck dissection; major surgical procedures; pedicled or free flap reconstruction; and predisposing medical conditions for UTI were significantly associated with greater length of hospitalization, whereas urgent or emergent admission; Medicare, Medicaid, or self-pay payor status; comorbidity; neck dissection; major surgical procedures; and pedicled or free flap reconstruction were significantly associated with increased hospital costs. The development of a UTI was associated with significantly increased length of hospitalization and hospital-related costs and had the largest impact on length of hospitalization and the second largest impact on costs of care, after major surgical procedure.

Discussion

In this study, UTI occurred in 2% of patients and was an independent predictor of acute medical and surgical complications, length of hospitalization, and hospital costs. Advanced age, comorbidity, major surgical procedures, and predisposing conditions justifying urinary catheter placement were significantly associated with an increased risk of UTI. Major surgical procedures were performed in more than 50% of patients, and predisposing conditions justifying urinary catheter placement were documented in 6% of patients, but urinary catheter placement was documented in less than 1% of patients, and catheter-associated UTI was rarely coded. These data suggest that catheter-associated UTI is undercoded, as has been reported by others.[15,16] Because the variables associated with UTI are also known to be associated with an increased risk of catheter-associated UTI, HNCA surgical patients represent a group at increased risk for catheter-associated UTI in whom prevention may not always be possible.

To date, there has been no previous investigation of UTI in the HNCA population. Our UTI rates are similar to those of patients undergoing cardiac, vascular, abdominal, and orthopedic procedures in the National Surgical Infection Prevention Project, who had similar rates of predisposing conditions justifying urinary catheter placement: in this data set, 86% of patients had perioperative urinary catheter placement.[6] At our institution, any patient undergoing a procedure whose duration is 3 hours or longer has a catheter placed at the time of surgery. In our study, it is likely that catheter placement, as well as catheter-associated UTI, is

Table 5. Multivariate Logistic Regression Analysis of Variables Associated with High-Volume Care and Risk of In-Hospital Death and Postoperative Complications

Variable	Odds Ratio	95% CI	*P* Value
In-hospital death			
Urgent/emergent admission	1.90	1.27-2.85	.002
Age >80 y	2.17	1.32-3.57	.002
Medicare	2.60	1.42-4.74	.002
Medicaid	2.46	1.31-4.64	.005
Comorbidity score 1	2.00	1.33-3.04	.001
Comorbidity score 2	5.24	3.27-8.39	<.001
Comorbidity score ≥3	6.30	3.59-11.06	<.001
Pedicled or free flap reconstruction	1.50	1.56-4.04	<.001
Major procedure	2.16	1.37-3.39	.001
Postoperative surgical complications			
Medicaid	1.26	1.06-1.50	.010
Pedicled or free flap reconstruction	1.88	1.60-2.22	<.001
Major procedure	2.54	2.24-2.87	<.001
Comorbidity score 1	1.17	1.03-1.31	.012
Comorbidity score 2	1.20	1.02-1.42	.026
UTI	2.31	1.70-3.14	<.001
Acute medical complications			
Urgent/emergent admission	1.52	1.31-1.76	<.001
Age 65-80 y	2.30	1.61-3.31	<.001
Age >80 y	3.79	2.27-5.57	<.001
Female sex	0.88	0.79-0.98	.016
Medicare	1.39	1.21-1.61	<.001
Medicaid	1.47	1.26-1.73	<.001
Comorbidity score 1	2.39	2.15-2.66	<.001
Comorbidity score 2	5.45	4.78-6.20	<.001
Comorbidity score ≥3	8.71	7.13-10.63	<.001
Major procedure	1.58	1.42-1.76	<.001
Pedicled or free flap reconstruction	1.47	1.24-1.75	<.001
UTI	3.06	2.26-4.14	<.001

Abbreviations: CI, confidence interval; UTI, urinary tract infection.

significantly undercoded. This likely reflects limitations of hospital discharge data; coders may not be able to distinguish between catheter-associated UTI and those UTIs that are not catheter associated, and during the time frame of this study, codes for hospital-acquired catheter UTI generated no additional payments when coded correctly, with no incentive to differentiate between these 2 conditions.[2] The implementation of CMS financial penalties will draw increased attention to this condition, which may have the beneficial intended effect of improved compliance with measures known to reduce catheter-associated UTI such as limiting the use of urinary catheterization, early removal of urinary catheters, and increased attention to aseptic insertion and catheter maintenance.[17] The use of such guidelines has been shown to reduce the incidence of catheter-associated UTI by more than 50% without increasing the risk of recatheterization, but the risk remains elevated in critically ill patients and those with predisposing conditions to catheter use such as prostate disease, urinary incontinence or obstruction, paralysis, or neurogenic bladder.[2,6,18-21] Because practices for prevention, surveillance, and documentation vary widely, the use of financial penalties may serve as an effective lever for guideline implementation where dissemination of evidence-based guidelines has failed.[3,22]

However, this policy may have unintended negative consequences, including intentional undercoding of catheter-associated UTI, prophylactic antibiotic prescribing in high-risk patients, a reduction in testing for UTI, and reduced access for patient populations at increased risk of infectious complications.[2,23] Our data demonstrate that urgent or emergent admission, advanced age and comorbidity, Medicaid payor status, major surgical procedures that may be a surrogate for more advanced stage disease, and predisposing medical conditions that justify urinary catheter insertion are associated with an increase in postoperative UTI, which in turn is significantly associated with medical and surgical complications, length of hospitalization, and costs, after controlling for all other variables. Length of urinary catheterization is associated with an increased risk of UTI, with each successive day of indwelling catheter use increasing the risk of UTI by 5%.[6,18] Many of the

Table 6. Generalized Linear Regression Analysis of Length of Stay and Hospital Costs

Variable	Estimate	95% CI	*P* Value	Mean
Length of stay, d				
Intercept	1.3451	1.2723-1.4187	<.001	7.5
Urgent/emergent admission	0.2873	0.2345-0.3400	<.001	2.2
Medicare	0.1384	0.0799-0.1969	<.001	1.0
Medicaid	0.3192	0.2581-0.3802	<.001	2.4
Self-pay	0.1608	0.0785-0.2431	<.001	1.2
Comorbidity score 1	0.1539	0.1145-0.1934	<.001	1.2
Comorbidity score 2	0.2979	0.2387-0.3571	<.001	2.2
Comorbidity score ≥3	0.4393	0.3472-0.5315	<.001	3.3
Pedicled or free flap reconstruction	0.2697	0.2062-0.3332	<.001	2.0
Major procedure	0.6899	0.6526-0.7272	<.001	5.2
UTI	0.7270	0.6154-0.8387	<.001	5.5
Predisposing conditions	0.0812	0.0164-0.1459	.014	0.6
Hospital costs (2012 US dollars)				
Intercept	9.5425	9.4468-9.6382	<.001	$22,692
Urgent/emergent admission	0.1448	0.0625-0.2271	.001	$3,286
Medicare	0.0846	0.0171-0.1521	.014	$1,920
Medicaid	0.2314	0.1705-0.2923	<.001	$5,252
Self-pay	0.0934	0.0143-0.1726	.021	$2,121
Comorbidity score 1	0.1094	0.0702-0.1486	<.001	$2,484
Comorbidity score 2	0.2748	0.2150-0.3347	<.001	$6,238
Comorbidity score ≥3	0.4061	0.3092-0.5030	<.001	$9,216
Pedicled or free flap reconstruction	0.3275	0.2642-0.3907	<.001	$7,432
Major procedure	0.6843	0.6478-0.7207	<.001	$15,528
UTI	0.6606	0.5498-0.7714	<.001	$14,992

Abbreviations: CI, confidence interval; UTI, urinary tract infection.

risk factors associated with UTI in our series are nonmodifiable risk factors that are common in the HNCA surgical population and are associated with an increased risk of postoperative complications and costs of care. Because catheter-associated UTI can be reduced but not completely eliminated in this high-risk population, financial penalties risk further limits on access for vulnerable populations who already have reduced access to care and have an increased incidence of nonmodifiable conditions that are often associated with hospital-acquired conditions.[5,24] Reimbursement for compliance with guidelines known to be associated with catheter-associated UTI rather than financial penalties for its occurrence would be a more equitable solution but will require national guideline development and adoption.

There are several limitations to the use of hospital discharge data that may influence our findings. The NIS database provides no follow-up data beyond the index admission, is limited to a 30-day postoperative window, and contains no information on stage of disease, grade, subtype, or survival. Thus, a meaningful analysis of long-term outcomes is not possible from the available data. The NIS database does not contain information regarding readmission, previous surgical procedures, or prior chemotherapy, which could potentially affect results with regard to the extent of surgery, length of hospital stay, or perioperative morbidity. There may be differences in the type of patient or disease that are not adequately captured. Although comorbidity scores were used for risk classification, the ability to adequately control for case mix is limited when discharge diagnoses from administrative databases are used. Postoperative complications may not be apparent at the time of discharge, and as a result, the incidence of complications may be underreported. Urinary catheter placement and catheter-associated UTI are likely underestimated because of undercoding of this complication, which may not be recognized and coded by administrative personnel, as previously reported.[15,16] Duration of catheterization and frequency of catheterization cannot be determined from the NIS, both of which are known risk factors for UTI, and the use of antimicrobial catheters and prevention measures cannot be determined. Another potential limitation is that the cost analysis was based on hospital-related charges, was adjusted for institutional expense-to-revenue ratios, and did not include physician-related costs, as these data are not contained in the NIS database.

Nevertheless, these data demonstrate a significant association between UTI and postoperative surgical complications, acute medical complications, length of hospitalization, and costs in HNCA patients after controlling for all other patient

variables, as well as demonstrate that inherent patient comorbidities that are prevalent in the HNCA population are associated with an increased risk of developing a UTI postoperatively. Catheter-associated UTI is rarely coded and is likely underestimated because of difficulty in distinguishing between a catheter-associated UTI and postoperative UTI in patients undergoing major surgical procedures, who routinely undergo urinary catheterization at surgery and in the early perioperative period. Patients with HNCA are a high-risk group for this ''never event,'' particularly as the population ages. Withholding reimbursement for catheter-associated UTI risks restricting care for this high-risk and vulnerable population. Rather, process measures ensuring aseptic technique, type of catheter used, and duration of catheter use should be rewarded to improve quality of patient care and reduce morbidity and costs.

Author Contributions

Jason Y. K. Chan, analyzed data, wrote article; **Yevgeniy R. Semenov**, analyzed data, revised article; **Christine G. Gourin**, collected data, analyzed data, revised article.

Disclosures

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