The Implications of Hospital Acquired Adverse Events on Mortality, Length of Stay and Costs for Patients Undergoing Radical Cystectomy for Bladder Cancer

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Purpose: The incidence of hospital acquired adverse events in radical cystectomy and their implications for hospital outcomes and costs remain poorly described. We describe the incidence of hospital acquired adverse events in radical cystectomy, and characterize its relationship with in-hospital mortality, length of stay and hospitalization costs.

Materials and Methods: We identified 10,856 patients who underwent radical cystectomy for bladder cancer at 1,175 hospitals in the Nationwide Inpatient Sample from 2001 to 2008. We used hospital claims to identify adverse events for accidental puncture, decubitus ulcer, deep vein thrombosis/pulmonary embolus, methicillin-resistant Staphylococcus aureus, Clostridium difficile, surgical site infection and sepsis. Logistic regression and generalized estimating equation models were used to test the associations of hospital acquired adverse events with mortality, predicted prolonged length of stay and total hospitalization costs.

Results: Hospital acquired adverse events occurred in 11.3% of all patients undergoing radical cystectomy (1,228). Adverse events were associated with a higher odds of in-hospital death (OR 8.07, $p < 0.001$), adjusted prolonged length of stay (41.3%) and total costs ($54,242 vs $26,306; $p < 0.001$) compared to no adverse events on multivariate analysis. The incremental total costs attributable to hospital acquired adverse events were $43.8 million. Postoperative sepsis was associated with the highest risk of mortality (OR 17.56, $p < 0.001$), predicted prolonged length of stay (62.22%) and adjusted total cost ($79,613).

Conclusions: With hospital acquired adverse events occurring in approximately 11% of radical cystectomy cases, they pose a significant risk of in-hospital mortality and higher hospitalization costs. Therefore, increased attention is needed to reduce adverse events by improving patient safety, while understanding the economic implications for tertiary referral centers with possible policy changes such as denial of payment for hospital acquired adverse events.

Key Words: urinary bladder neoplasms, complications, costs and cost analysis, treatment outcome, cystectomy

Abbreviations and Acronyms

AEs = adverse events

CMS = Centers for Medicare and Medicaid Services

DVT = deep vein thrombosis

GEE = generalized estimating equation

LOS = length of stay

MRSA = methicillin-resistant Staphylococcus aureus

NIS = Nationwide Inpatient Sample

PE = pulmonary embolus

RC = radical cystectomy

SSI = surgical site infection

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HOSPITAL acquired adverse events have been well recognized for significantly increasing the risk of mortality and for higher costs.[1,2] Increased attention to patient safety by reducing medical errors is integral in improv-

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ing quality of care and patient outcomes. With preventable AEs due to medical errors costing an estimated $17.1 billion annually,[3] hospital payments for patients who experience AEs have recently undergone considerable policy changes in the determination of who should be responsible for the additional costs of care.[4,5] As a result, CMS recently started to withhold reimbursement for hospitalization costs attributable to never events, which have been defined as reasonably preventable hospital acquired AEs.[6]

With 73,350 individuals diagnosed with bladder cancer annually, a significant proportion of patients will undergo radical cystectomy.[7] However, compared to other urological operations, RC carries a particularly high risk of surgical morbidity and mortality. Postoperative rates of complications and mortality for RC have been estimated at approximately 30% to 60% and 1% to 3%, respectively.[8–10] Since postoperative complications markedly increase the risk of hospital mortality, LOS and charges,[11] they may represent a logical target for policy changes for reimbursement of hospital acquired AEs in an effort to improve patient safety and reduce costs. With the incidence of hospital acquired AEs in RC unknown, it is essential to first describe the occurrence of these AEs since the denial of payment may have unintended consequences in an oncologic operation carrying high morbidity that has already become increasingly regionalized to tertiary referral medical centers.[12–15] In this context we describe the incidence of hospital acquired AEs in patients undergoing RC for bladder cancer, and characterize the relationships with in-hospital mortality, LOS and total costs.

MATERIALS AND METHODS

Study Population

Data for all patients who underwent RC for bladder cancer were abstracted from the 2001 to 2008 NIS. The NIS from the Healthcare Cost and Utilization Project represents the largest all-payer inpatient care database in the United States and contains approximately a fifth of all admissions from a stratified sample.[16] To identify our analytic cohort we adopted a methodology described previously using hospital claims from ICD-9 codes.[8,10,13] We identified patients who had a bladder neoplasm (188.0–188.9) from the primary or secondary diagnostic codes and concomitant procedure codes for RC (57.71 and 57.79) from any of the procedure codes in the NIS. Using this methodology for case ascertainment, we identified 12,007 patients who underwent RC for bladder cancer. We excluded 1,151 patients younger than age 18 years at RC or those missing in-hospital total costs data, resulting in an analytic cohort of 10,856 individuals.

Patient and Hospital Covariates

Clinical information included as covariates was patient age, gender, race, primary insurance payer, admission type (elective vs emergent), median zip code income ($1 to $38,999; $39,000 to $47,999; $48,000 to $62,999 and $63,000 or greater), and time of surgery (2001 to 2002, 2003 to 2004, 2005 to 2006 and 2007 to 2008). With a quarter of individuals missing a race designation, we created an indicator variable to include these cases. Secondary diagnostic codes were used to define an Elixhauser comorbidity index.[17] The primary insurance payer was categorized into private health insurance, Medicare, Medicaid and other. We also evaluated hospital teaching status (nonteaching vs teaching), location (urban vs rural) and case volume as covariates. To account for the possible effect of hospital volume on study outcomes, we dichotomized RC hospital volume into the top 90th percentile of annual mean RC for high volume (15 or more RCs per year) and less than 90th percentile for low to medium RC volume.

Defining Hospital Acquired AEs

To define hospital acquired AEs, we used never events and other in-hospital complications described by previously published studies to ascertain which were applicable to RC, and considered potentially preventable and hospital acquired.[6,8] We used ICD-9 codes from the secondary diagnoses to define each hospital acquired AE, and categorized them into the groups of accidental puncture or laceration (by a catheter or instrument on a blood vessel, nerve, or organ), C. difficile, decubitus ulcer, DVT/PE, MRSA, SSI and sepsis. Among the CMS defined never events, these covariates included decubitus ulcer, DVT/PE and SSI. Due to a low number of events detected for other never events, we excluded foreign bodies accidentally left after surgery (6) and air embolism (1) as covariates in our analysis. An overall AE variable was defined as the presence of 1 or more events.

Outcomes

The primary outcomes were in-hospital mortality, defined as inpatient death, and total hospitalization cost. The secondary outcome evaluated in our study was prolonged LOS. We defined a procedure specific, prolonged LOS as the 90th percentile for RC (more than 18 days). Total hospitalization costs were calculated by adjusting the charges using the cost-to-charge ratio as provided by the NIS.[18] All total costs were reported in 2008 U.S. dollars with inflation adjustment using the Consumer Price Index.[19]

Statistical Analysis

Descriptive statistics were used to summarize patient and hospital characteristics. We fit multilevel/mixed effects multivariate logistic regression models to test the associations of patient and hospital variables and hospital acquired AEs with the primary outcome of in-hospital mortality, while also adjusting for the clustering of patient covariates to the hospital level. To determine the predicted probabilities of prolonged LOS and adjusted total hospitalization costs attributable to each type of AE and overall, we used GEEs to adjust for patient and hospital covariates, the type of AE and clustering of patients to the hospital level. In-hospital death and prolonged LOS were defined as binary variables in their respective models. In both models the independent covariates evaluated were