Nationwide Trends and Variations in Urological Surgical Interventions and Renal Outcome in Patients with Spina Bifida

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Purpose: Bladder dysfunction in patients with spina bifida can lead to significant morbidity due to renal insufficiency. Indications for surgery vary among institutions and the impact is unclear. We examined trends and variations in urological interventions and chronic renal insufficiency in patients with spina bifida.

Materials and Methods: We reviewed NIS (Nationwide Inpatient Sample) for all patients with spina bifida treated from 1998 to 2011. We used ICD-9-CM codes to identify urological surgery and chronic renal insufficiency. We calculated the Spearman correlation coefficients between rates of spina bifida related bladder surgeries and rates of chronic renal insufficiency outcomes by state. Linear regression models were fitted to investigate the associations between rates of spina bifida related surgery and chronic renal insufficiency across treatment years.

Results: We identified 427,616 spina bifida hospital admissions. Mean patient age was 26 years and 56% of patients were female. Of the admissions 35,249 (8%) were for chronic renal insufficiency and 11,078 (3%) were for surgery. During the study period chronic renal insufficiency rates doubled from 6% to 12% and surgery rates decreased from 2.0% to 1.8%. There was a moderately weak inverse association between surgery and chronic renal insufficiency rates with time ($r = -0.3$, $p = 0.06$) and by state ($r = -0.3$, $p = 0.04$). On multivariate analysis higher rates of surgery were associated with the state in which the patient was treated ($p < 0.001$), and with younger age ($p < 0.001$) and hospital teaching status ($p < 0.001$). In contrast, chronic renal insufficiency was not associated with spina bifida related surgery ($p = 0.67$).

Conclusions: We observed a temporal and geographic trend toward decreasing urological surgery and increasing chronic renal insufficiency rates in spina bifida and a wide variation in urological surgical rates among states. Further study is needed to determine the factors behind these trends and variations in spina bifida management.

Key Words: urinary bladder, neurogenic; kidney; spinal dysraphism; renal insufficiency, chronic; urologic surgical procedures

Abbreviations and Acronyms

CRI = chronic renal insufficiency

SB = spina bifida

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SPINA bifida, a major congenital defect in which the neural tube fails to close properly during embryonic development, is the most common permanently disabling birth defect in the United States.[1,2] Due to its involvement in multiple organ systems treating children with SB presents many complex

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urological challenges. More than 90% of affected individuals will have neurogenic bladder.[3] Therefore, careful and attentive bladder management is paramount to preserve maximal renal function and achieve the best possible quality of life.[4,5]

Approaches to bladder management include routine monitoring with imaging and urodynamic study, anticholinergic medications, clean intermittent catheterization and various surgeries including but not limited to enterocystoplasty (bladder augmentation), bladder neck sling, sphincterotomy, urinary diversion (vesicostomy or ileal conduit), artificial urinary sphincter, botulinum toxin injection and creation of catheterizable stomas (appendicovesicostomy or Monti channel). Indications for surgery vary significantly among institutions and providers, and the ideal strategy remains unclear.[6]

As an increasingly large number of children with SB are surviving beyond infancy into childhood and adolescence as a result of modern medical and surgical advances,[7] evaluation of different bladder management approaches to achieve the best long-term outcomes is critical. It is known that high bladder storage pressures related to neurogenic bladder can lead to renal insufficiency and bladder augmentation is not infrequently performed to reduce bladder pressure to protect the kidneys. Institutional series have shown rather low morbidity and mortality of various urological surgical interventions in modern series.[8–10] However, the impact of those surgeries on long-term renal function is unclear. Little long-term outcome data on bladder management strategies are available to help determine best practices in terms of the indication and timing of those procedures. On the other hand the operative morbidity of bladder augmentation is well described, including bladder stones, malignancy or spontaneous perforation.[11,12] Therefore, groups at some centers have endorsed a less surgically oriented approach to manage neurogenic bladder in children and adults with SB[13] due to the advancement of new anticholinergic medications with fewer side effects, close monitoring with imaging and urodynamics, and increasing awareness of potential long-term complications of SB related surgeries.[12,14]

The objective of this study was to use a national database to expand perspectives on the variation of CRI and SB related urological surgery to gain insight on their relationship. We hypothesized that urological surgery rates, specifically bladder augmentation, would be inversely related to CRI rates.

PATIENTS AND METHODS

Data Source

NIS is an all age, all payer database managed by HCUP (Healthcare Cost and Utilization Project) and sponsored by AHRQ (Agency for Healthcare Research and Quality). Data in NIS are from a 20% stratified probability sample of American hospitals based on 5 hospital characteristics, including ownership status, number of beds, teaching status, urban/rural location and geographic region. NIS includes post-stratification discharge weights that may be used to calculate national estimates.[15]

Selection

Patients and Covariates. We identified all inpatient hospital encounters occurring between 1998 and 2011 for patients with a ICD-9-CM diagnosis code for SB (741.X and 756.17). Predictor variables were selected a priori based on biological plausibility and/or demonstrated associations in the literature. Covariates included basic patient demographics such as age, gender, race, insurance payer (public vs private), ZIP Code™ median household income (by quartile) and year of admission as well as hospital level factors such as hospital characteristics (hospital teaching or nonteaching status), state and hospital size according to number of beds (small, medium and large).

Outcomes. The primary outcomes were SB related urological surgery and CRI. We defined SB related urological surgeries to include bladder augmentation, bladder neck sling, sphincterotomy, vesicostomy, artificial urinary sphincter, botulinum toxin injection, appendicovesicostomy and urinary diversion. Surgeries were identified by ICD-9-CM procedure codes (see Appendix). CRI was defined based on ICD-9-CM codes for chronic kidney disease (585) and renal failure, unspecified (586), CCS (Clinical Classifications Software) codes (157 and 158) and/or procedure codes for dialysis or renal transplantation (58, 91 and 105). CCS codes are based on ICD-9-CM codes and were developed by AHRQ specifically for use in administrative data.[16]

Statistical Analysis

All analyses were weighted using NIS specific estimated weights and covariance matrices. We calculated the Spearman correlation coefficients to assess the relationship between rates of SB related urological surgery in each state and rates of CRI outcomes in the same state. Linear regression models were fitted to investigate associations between rates of SB related urological surgery and CRI with time.

Weighted logistic regression models were used to define associations of patient and hospital level factors with SB related urological surgery. Model covariates were determined a priori based on our conceptual model. The importance of each covariate was examined by comparing sequential nested models. We also performed sensitivity analysis examining the effects of these factors using generalized estimating equations to control for clustering of similar patients in each hospital and each state. All analyses were performed using SAS®, version 9.4. All tests were 2-sided with $p \leq 0.05$ considered significant.

RESULTS

Demographics

In total we identified 427,616 SB hospital admissions from the 1998 to 2011 NIS (supplementary