# Regional Variation in Total Cost per Radical Prostatectomy in the Healthcare Cost and Utilization Project Nationwide Inpatient Sample Database

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**Abbreviations and Acronyms**

CaP = prostate cancer

CMS = Centers for Medicare and Medicaid Services

HCUP = Healthcare Cost and Utilization Project

NIS = Nationwide Inpatient Sample

RP = radical prostatectomy

TC = total cost

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**Purpose:** Surgical treatment for prostate cancer represents a large national health care expenditure. We determined whether state level variation in the cost of radical prostatectomy exists and whether we could explain this variation by adjusting for covariates associated with cost.

**Materials and Methods:** Using the 2004 Healthcare Cost and Utilization Project National Inpatient Sample of 7,978,041 patients we identified 9,917 who were 40 years old or older with a diagnosis of prostate cancer who underwent radical prostatectomy without cystectomy. We used linear regression to examine state level regional variation in radical prostatectomy costs, controlling for the local area wage index, patient demographics, case mix and hospital characteristics.

**Results:** The mean ± SD unadjusted cost was $9,112 ± $4,434 (range $2,001 to $49,922). The unadjusted mean cost ranged from $12,490 in California to $4,650 in Utah, each significantly different from the mean of $8,903 in the median state, Washington ($p < 0.0001$). After adjusting for all potential confounders total cost was highest in Colorado and lowest in New Jersey, which were significantly different from the median, Washington ($10,750 and $5,899, respectively, vs $8,641, $p < 0.0001$). The model explained 85.9% of the variance with regional variation accounting for the greatest incremental proportion of variance (35.1%) and case mix variables accounting for an incremental 32.3%.

**Conclusions:** The total cost of radical prostatectomy varies significantly across states. Controlling for known total cost determinants did not completely explain these differences but altered ordinal cost relationships among states. Cost variation suggests inefficiencies in the health care market. Additional studies are needed to determine whether these variations in total cost translate into differences in quality or outcome and how they may be translated into useful policy measures.

**Key Words:** prostatic neoplasms, prostatectomy, health policy, small-area analysis, costs and cost analysis

PROSTATE cancer is the most commonly diagnosed noncutaneous malignancy in American men with approximately 186,320 incident cases in 2008.[1] The total annual national expenditure on CaP in the United States is high with estimates ranging between $1.72 billion[2] and $4.75 billion[3] annually according to 1990 costs.[4] The cost burden to taxpayers is also substantial



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with $927 million spent on CaP care for Medicare beneficiaries in 2001.[5] Approximately 48% of spending on CaP treatment is associated with inpatient care, of which a large fraction is attributable to surgery.[5]

A Scandinavian randomized trial showed that RP is superior to watchful waiting for CaP.[6–8] However, no randomized data exist on the comparative effectiveness of other available therapies, such as radiation or active surveillance etc.[9,10] Accordingly therapeutic uncertainty has led to wide variation across American geographic areas in procedures used to treat CaP, such as RP.[11–13]

However, the choice of therapy may be influenced not only by uncertainty about oncological superiority but also potentially by cost since patients are known to use less health care and less expensive health care when they are forced to pay for it out of pocket.[4,14,15] Likewise providers of medical services produce less of any service as its cost increases.[16,17] Since legal and payment mechanisms vary across states, we determined whether there is also state level variation in the cost of RP and whether we could explain this variation by adjusting for regional and patient level variables associated with cost.

## METHODS

We used data available in 2009 from the 2004 HCUP-NIS (HCUP Databases. Healthcare Cost and Utilization Project [HCUP]. August 2009. Agency for Healthcare Research and Quality, Rockville, MD. www.hcup-us.ahrq.gov/nisoverview.jsp.), a 20% stratified sample of discharges from community hospitals representing the largest all payer, inpatient care database in the United States. Additional subfiles, the HCUP 2004 cost-to-charge ratio and hospital weights files, were merged with the core file to determine economic costs and hospital level covariates.

The database included data on 7,978,041 inpatient discharges from 2004. Since RP can only be performed once in any patient, we assumed that hospital discharges listing the RP procedure code identified unique patients. We limited data on the 3,264,088 men to the 2,171,128 who were 40 years old or older. We identified 11,254 patients with a diagnosis of CaP (ICD-9 code 185) who underwent RP (ICD-9 procedure code 60.5). We excluded from study 1,264 patients with missing data other than race and 17 who underwent simultaneous cystectomy (ICD-9 procedure codes 57.6, 57.7, 57.71 or 57.79) since this would indicate CaP diagnosed during treatment for bladder cancer. Based on analysis suggesting natural breaks at the low and high ends of the TC distribution we excluded 52 patients in whom TC was less than $2,000 and 21 in whom TC was greater than $50,000, leaving a final study sample of 9,917.

The primary outcome variable was TC, determined by multiplying total charges by a hospital wide, all payer inpatient cost-to-charge ratio per hospital derived from CMS standardized hospital accounting reports. This ratio removes differences in markup used by hospitals to account for differences in payer mix, local competition and price strategy.[18] Documentation, data and reports on cost estimation methods are available from the Agency for Healthcare Research and Quality.

The primary independent variable was the state in which the hospital is located. The 2004 HCUP-NIS contains data from 37 states but no records from Hawaii were available of men undergoing RP and no cost-to-charge conversion data were available from Texas. The local area wage index developed for CMS reimbursement accounts for geographic variations in the price of hospital inputs endogenous to the local market. To allow for variable cost elasticity with respect to input prices we used this index as an explanatory variable.[18] Covariates were classified into 3 classes, including patient demographics, case mix and hospital factors.

Demographics included race, urban-rural residence, median income in the patient residential ZIP Code™ and primary insurance payer. Race was classified as a 4-level variable comprising race and ethnicity (white, black, other or missing). White was the reference group. Other included Hispanic, Asian or Pacific Islander, Native American or other patients. Urban-rural residence was a 4-level variable describing county of residence, including large metropolitan (1,000,000 or more residents), small metropolitan (fewer than 1,000,000 residents) and micropolitan or nonurban (reference). Quartile classification of the estimated median household income in the patient ZIP Code was defined as $1 to $35,999, $36,000 to $44,999, $45,000 to $58,999, or $59,000 or greater with the lowest income serving as the reference. Primary insurance payer was coded as a 3-level variable, including private insurance; Medicare or Medicaid; or self-pay, no charge or other payer. Private insurance was the reference.

Case mix included the continuous variables age in years, length of stay in days and number of procedures (maximum 15) as well as the 2 categorical variables alive (reference) or dead at hospital discharge, and a comorbidity score. Using the updated method of Elixhauser et al[19] we determined the presence or absence of ICD-9 codes corresponding to any of 29 comorbidity measures according to HCUP-NIS (HCUP Databases. Healthcare Cost and Utilization Project [HCUP]. August 2009. Agency for Healthcare Research and Quality, Rockville, MD. www.hcup-us.ahrq.gov/nisoverview.jsp.). They were summed and grouped into the categories of 0, 1 to 2, or 3 or greater comorbidities. Hospital characteristics were bed size, designated by HCUP as small, medium or large based on the number of beds specific to the hospital location and teaching status. Ownership/control was stratified as public, voluntary (reference) and proprietary when a hospital and region were sufficiently large. In smaller strata public and private were combined with voluntary and proprietary hospitals comprising an individual private category. A separate category was created when no stratification was advisable due to limited hospital numbers according to HCUP-NIS. Teaching status was binary, including teaching (reference) or nonteaching. Urban-rural location, coded as rural vs urban (reference), was defined by Core Based Statistical Area codes.

Bivariate association between each covariate and TC was assessed by simple linear regression for continuous variables and ANOVA for categorical variables. Unadjusted mean TCs were calculated for each level of the categorical variables. The slope (change in TC per unit