

# Evaluation of the Charges, Safety, and Mortality of Percutaneous Renal Thermal Ablation Using the Nationwide Inpatient Sample

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## ABSTRACT

**Purpose:** To perform a national analysis of safety, charges, complications, and mortality of percutaneous image-guided renal thermal ablation and compare outcomes by hospital volume.

**Materials and Methods:** Using the Nationwide Inpatient Sample, trends in the proportion of inpatient percutaneous renal thermal ablation procedures performed at high-volume centers in the United States from 2007–2011 were evaluated. In-hospital mortality, discharge to long-term care facility, length of stay, hospitalization charges, and postoperative complications were compared between high-volume and low-volume ablation centers. High volume was set at the 90th percentile for renal thermal ablation volume, which equated to seven or more patients per year. A multivariate logistic regression analysis adjusting for hospital volume, age, sex, Charlson Comorbidity Index, obesity, race, and insurance status was performed to analyze the influence of hospital volume on the above-listed outcomes.

**Results:** This study included 874 patients. The number of hospitals ranged from 59–77 depending on year. Overall, 328 patients (37.5%) were treated at high-volume ablation centers. The proportion of patients treated at high-volume centers decreased from 42.0% in 2007–2009 to 28.5% in 2010–2011. High-volume hospitals also performed significantly more partial nephrectomies than low-volume hospitals. On multivariate logistic regression analysis, increasing hospital volume was associated with lower odds of in-hospital mortality (odds ratio [OR] = 0.31, 95% confidence interval [CI] = 0.02–0.95) and lower odds of discharge to a long-term care facility (OR = 0.00, 95% CI = 0.00–0.66). Increasing hospital volume was also associated with lower odds of blood transfusion (OR = 0.84, 95% CI = 0.72–0.94). Length of stay decreased with increasing hospital volume ( $P = .03$ ).

**Conclusions:** Patient safety may be maximized when renal ablation is performed at high-volume centers as a result of both greater procedural experience and potentially multidisciplinary triage and periprocedural management.

## ABBREVIATIONS

CCI = Charlson Comorbidity Index, CI = confidence interval, ICD-9 = International Classification of Diseases, Ninth Revision, NIS = Nationwide Inpatient Sample, OR = odds ratio

This year > 65,000 cases of renal cell carcinoma will be diagnosed in the United States with overall incidence of

disease increasing (1,2). Percutaneous ablation offers a minimally invasive thermal alternative to surgical resection in appropriately selected patients with small renal tumors with an increasingly established safety profile and oncologic efficacy (3–6). Consensus guidelines from the American Urological Association now include percutaneous ablation as part of the treatment algorithm for patients with T1a renal tumors who have increased potential for surgical morbidity (7). Expanding evidence supporting a role for thermal ablation in treatment algorithms has led to increasing demand for this minimally invasive treatment at centers across the United States. Additionally, a

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multitude of subspecialty providers have begun offering ablative treatments as part of their practice scope. As a result of these recent changes in renal ablation practice, we examined trends in renal thermal ablation charges, safety, and complications based on center volume in the United States. Because outcomes related to percutaneous image-guided renal ablation might vary with experience, we compared charges, complications, and mortality by hospital procedure volume.

## MATERIALS AND METHODS

### Patient Population

The Nationwide Inpatient Sample (NIS) hospital discharge database for 2007–2011 was purchased from the Health Care Utilization Project of the Agency for Healthcare Research and Quality, Rockville, Maryland. The NIS is a hospital discharge database that represents 20% of all inpatient admissions to nonfederal hospitals in the United States. We selected all patients receiving percutaneous renal thermal ablation (International Classification of Diseases, Ninth Revision [ICD-9] procedure code 5533). Patients treated with laparoscopic ablation were excluded. For each patient, the following demographic and comorbidity information was collected: age, gender, race, income, insurance status, hospital location and teaching status, symptomatic status, obesity (ICD-9 codes 27800–27802), and Charlson Comorbidity Index (CCI) (8). In addition, data about the volume of partial nephrectomies (ICD-9 procedure code 55.4) performed at each center were collected. Centers at the 90th percentile of nephrectomy volume per year (72 partial nephrectomies/y) or greater were considered high-volume centers. Information regarding the collection of data elements is provided in the document “Introduction to the HCUP Nationwide Inpatient Sample (NIS)—2011” (9). Hospitalization charges were adjusted for inflation to the level of 2011.

### Outcomes

The number of patients receiving percutaneous image-guided thermal ablation from 2007–2011 was collected, and the proportion of patients treated at high-volume centers from 2007–2011 was obtained by dividing the study into two time periods, 2007–2009 and 2010–2011. We also compared the rates of discharge to a long-term care facility, in-hospital mortality, postoperative complications (ICD-9 codes 997.0–997.9), length of stay, inflation-adjusted hospitalization charges (2011 adjusted), hemorrhagic complications (ICD-9 codes 998.11–998.12), and blood transfusion requirement (ICD-9 code 990.4) between patients treated at high-volume and low-volume centers.

### Stratification of Hospital by Annual Procedure Volume

Hospital codes were provided, and we were able to determine the number of ablations performed at each institution in a given year. We stratified hospital volume on the basis of percutaneous renal thermal ablation procedures performed per individual year at each center. High-volume centers were identified as centers that were  $\geq$  90th percentile for procedure volume; this threshold translated to seven or more cases per year. Using this threshold, we stratified the distribution of centers by procedure volume.

### Statistical Analysis

No discharge weights were applied for the purposes of this analysis. All categorical variables were compared by procedure volume with  $\chi^2$  analyses. All continuous variables were compared by procedure volume using the Student *t* test. Multivariate logistic regression models were fit to determine if hospital volume was an independent predictor of in-hospital mortality, discharge to a long-term care facility, other postoperative complications, hemorrhagic complications, and blood transfusions. Standard least-squares models were used for analysis of hospitalization charges and length of stay. Independent variables included in these analyses were hospital volume, age, gender, race, insurance status, obesity, partial nephrectomy volume, and CCI (8). Partial nephrectomy volume, CCI, and age were operationalized as continuous variables. Ablation volume was operationalized as a continuous variable, and results were reported on a per unit increase basis for the multivariable analysis. All data analysis was performed using the SAS-based statistical software package JMP 10.0 Pro (SAS Institute, Inc, Cary, North Carolina).

## RESULTS

### Patient and Hospital Characteristics

According to the NIS, 874 patients underwent percutaneous image-guided ablation during 2007–2011 and were included for analysis. The total number of patients treated per year was 182 in 2007, 204 in 2008, 200 in 2009, 104 in 2010, and 184 in 2011. The total number of patients includes 546 patients (62.5%) treated at low-volume centers and 328 patients (37.5%) treated at high-volume centers. The proportion of patients treated at high-volume centers decreased from 42.0% (246 of 586) in 2007–2009 to 28.5% (82 of 288) in 2010–2011 ( $P < .0001$ ). Patients treated at low-volume centers had a mean age of 69.5 years compared with a mean age of 67.1 years for patients treated at high volume centers ( $P = .01$ ). Patients treated with percutaneous image-guided renal ablation at low-volume centers had a mean CCI of 3.5 compared with 3.2 at high-volume centers ( $P = .003$ ). No statistically significant racial disparities

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