



## Original Article

# Thirty-day hospital revisits after prostate brachytherapy: who is at risk?



Belinda Li <sup>a,\*</sup>, Eric J. Kirshenbaum <sup>a</sup>, Robert H. Blackwell <sup>a</sup>, William S. Gange <sup>b</sup>, Jennifer Saluk <sup>b</sup>, Matthew A.C. Zapf <sup>b</sup>, Anai N. Kothari <sup>c</sup>, Robert C. Flanigan <sup>a</sup>, Gopal N. Gupta <sup>a,c</sup>

<sup>a</sup> Department of Urology, Loyola University Medical Center, Maywood, IL 60153, United States

<sup>b</sup> Loyola University Chicago, Stritch School of Medicine, Maywood, IL 60153, United States

<sup>c</sup> Department of Surgery, Loyola University Medical Center, Maywood, IL 60153, United States

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## ABSTRACT

**Background:** Transperineal prostate brachytherapy is a common outpatient procedure for the treatment of prostate cancer. Whereas long-term morbidity and toxicities are widely published, rates of short-term complications leading to hospital revisits have not been well described.

**Materials and methods:** Patients who underwent brachytherapy for prostate cancer in an ambulatory setting were identified in the Healthcare Cost and Utilization Project State Ambulatory Surgery Database for California between 2007 and 2011. Emergency department (ED) visits and inpatient admissions within 30 days of treatment were determined from the California Healthcare Cost and Utilization Project State Emergency Department Database and State Inpatient Database, respectively.

**Results:** Between 2007 and 2011, 9,042 patients underwent brachytherapy for prostate cancer. Within 30 days postoperatively, 543 (6.0%) patients experienced 674 hospital encounters. ED visits comprised most encounters (68.7%) at a median of 7 days (interquartile range 2–16) after surgery. Inpatient hospitalizations occurred on 155 of 674 visits (23.0%) at a median of 12 days (interquartile range 5–20). Common presenting diagnoses included urinary retention, malfunctioning catheter, hematuria, and urinary tract infection. Logistic regression demonstrated advanced age {65–75 years: odds ratio [OR], 1.3 [95% confidence interval (CI) 1.06–1.60,  $P = 0.01$ ]; >75 years: OR 1.5 [95% CI 1.18–1.97,  $P = 0.001$ ]}, inpatient admission within 90 days before surgery [OR 2.68 (95% CI 1.8–4.0,  $P < 0.001$ )], and ED visit within 180 days before surgery [OR 1.63 (95% CI 1.4–1.89,  $P < 0.001$ )] as factors that increased the risk of hospital-based evaluation after outpatient brachytherapy. Charlson comorbidity score did not influence risk.

**Conclusions:** ED visits and inpatient admissions are not uncommon after prostate brachytherapy. Risk of revisit is higher in elderly patients and those who have had recent inpatient or ED encounters.

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## 1. Introduction

Prostate cancer is the most common cancer in men, with an incidence of more than 180,000 cases per year in the United States.<sup>1</sup> Treatment options for men with localized disease include active surveillance, brachytherapy, external beam radiotherapy (EBRT), and radical prostatectomy. Transperineal prostate brachytherapy is

a common outpatient procedure for the treatment of low-risk prostate cancer, which is associated with high rates of overall survival, disease-free survival, and biochemical control.<sup>2,3</sup>

Prostate brachytherapy offers certain advantages to radical prostatectomy and EBRT primarily because of its shorter treatment and recovery times. It represents an outpatient, minimally invasive option that allows most patients to return to their normal activities in 1–2 days.<sup>4</sup> Furthermore, compared to EBRT, brachytherapy limits radiation exposure to the target tissue, with a sharp dose fall-off in adjacent healthy tissues leading to reduced toxicities.<sup>5</sup> As with each treatment modality, brachytherapy also carries its own set of risks and complications. The most common early side effects of prostate

\* Corresponding author. Department of Urology, Loyola University Medical Center, 2160 S 1<sup>st</sup> Avenue, Building 54, Room 261, Maywood, IL 60153, United States.  
E-mail address: [beli@lumc.edu](mailto:beli@lumc.edu) (B. Li).

brachytherapy include urinary retention, erectile dysfunction, urinary incontinence, urinary tract infection (UTI), proctitis, hematuria, rectal ulcers, and diarrhea.<sup>5–8</sup> In addition, urinary symptoms have been shown to lead to transurethral resection of the prostate in up to 8.3% of cases.<sup>9</sup> The factors previously shown to be associated with the development of complications include older age, nonwhite race, combined treatment with EBRT, and higher Charlson comorbidity score.<sup>5</sup>

Although long-term complications and their risk factors, as well as future treatment rates, have been well described, the rates of emergency department (ED) visits and inpatient admissions after brachytherapy are not as well described. We aim to determine these rates and the patient-specific factors associated with early hospital visits after outpatient brachytherapy. With this knowledge, we will be able to better inform our patients of potential complications and to identify patients who are at risk preoperatively.

## 2. Material and methods

### 2.1. Data source

The Healthcare Cost and Utilization Project (HCUP) State Inpatient Database (SID), State Ambulatory Surgery and Services Database (SASD), and State Emergency Department Database (SEDD) for the state of California were used for the years 2007–2011. The HCUP SID includes patient discharge records for all payers within an individual state; the HCUP SASD includes data from ambulatory surgeries and outpatient services; and the HCUP SEDD captures ED visits.<sup>10</sup> Patient data are deidentified and include greater than 100 clinical and nonclinical variables. The dataset has unique linkage variables that allows patients to be followed longitudinally across outpatient, ED, and inpatient encounters.<sup>10,11</sup>

### 2.2. Patient selection

We identified patients with a diagnosis of prostate cancer who underwent outpatient prostate brachytherapy using International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes and Current Procedural Terminology (CPT) codes. We used their unique linkage variables to follow them up longitudinally in both the inpatient and ED databases. Hospital admissions and ED visits before the index procedure were assessed for all patients. [Supplementary Appendix 1](#) lists the CPT and ICD9-CM codes used in this study.

### 2.3. Outcome measures

Patients who underwent prostate brachytherapy were assessed retrospectively. We identified those patients who had a hospital encounter—either an inpatient admission or ED visit within 30 days after brachytherapy, specifically assessing their presenting diagnoses. Baseline patient characteristics including age, race, and primary insurance provider and medical comorbidities (diabetes, heart failure, cerebrovascular accident, myocardial infarction, chronic lung disease, renal insufficiency, and peripheral vascular disease) were assessed. Severity of comorbid disease burden was measured with the Charlson Comorbidity Index. Two additional variables included in the analysis were prior ED visits within 180 days and prior inpatient admission within 90 days of the procedure, both derived from previous work that has found the presence of these factors to place patients at greater risk for 30-day readmission.

### 2.4. Statistical analysis

Descriptive statistics were performed. Continuous variables were reported as medians and interquartile range (IQR), with Wilcoxon rank-sum test performed to assess significance. For categorical variables, Chi-square tests were performed. A univariable logistic regression was performed to identify patient factors and comorbidities as predictors of hospital evaluation. Those factors with a  $P < 0.1$  on univariable analysis were included in a multivariable logistic regression model to determine independent predictors for a hospital-based medical evaluation after prostate brachytherapy. Stata 13 (StataCorp, College Station, TX, USA) was used for all statistical analysis, with a threshold for statistical significance of  $P < 0.05$ .

## 3. Results

Between 2007 and 2011, 9,042 patients underwent brachytherapy for prostate cancer. [Table 1](#) describes the baseline characteristics and comorbidities of our patient population. The median age of our cohort was 67 years. Patients were primarily Caucasian (62.7%) and had either Medicare (50.3%) or private insurance (45.4%). [Table 2](#) analyzes encounters within 30 days of the index procedure. Within 30 days of brachytherapy, 543 (6.0%) patients experienced 674 hospital encounters. ED visits comprised a majority (463 visits, 68.7%) at a median time of 7 days from surgery (IQR 2–16). A total of 155 of 674 (23%) encounters were inpatient admissions at a median time of 12 days (IQR 5–20) postoperatively. Common presenting diagnoses included urinary retention (52.8%), hematuria (11.6%), UTI (11.6%), and malfunctioning of urethral catheter (39.47%). No additional diagnoses reached individually reported thresholds of  $n > 10$ .

On univariate analysis ([Table 3](#)), age [65–75 years: odds ratio (OR) 1.36, confidence interval (CI) 1.11–1.65,  $P = 0.003$ ; >75 years: OR 1.66, CI 1.3–2.13,  $P < 0.001$ ] and Asian race (OR 2.22, CI 1.61–3.05,  $P = 0.003$ ) were found to significantly influence the risk for a hospital-based evaluation within 30 days of brachytherapy.

**Table 1**  
Baseline patient characteristics.

	N (%)
<b>Number of patients</b>	9042
<b>Age (years), median (IQR)</b>	67 (61–72)
<b>Race</b>	
Caucasian	5674 (62.8)
Black	423 (4.7)
Hispanic	692 (7.7)
Asian	446 (4.9)
Other/Unknown	1807 (20.0)
<b>Primary insurance provider</b>	
Medicare	4554 (50.4)
Medicaid	92 (1.0)
Private	4103 (45.4)
Self-pay	159 (1.8)
Other	134 (1.5)
<b>Medical comorbidities</b>	
Diabetes mellitus	825 (9.1)
Congestive heart failure	45 (0.5)
Prior cerebral vascular accident	26 (0.3)
Prior myocardial infarction	183 (2.0)
Chronic lung disease	457 (5.0)
Chronic renal insufficiency	133 (1.5)
Peripheral vascular disease	53 (0.6)
Charlson Comorbidity Index, median (IQR)	2 (0–2)
<b>Prior hospital visit</b>	
Emergency department (within 180 days)	617 (6.8)
Inpatient hospitalization (within 90 days)	195 (2.2)

IQR, interquartile range.

**Table 2**  
Encounter within 30 days.

	N (%)
Total hospital revisits within 30 days	674
Number of patients	543 (6.01)
ED visits within 30 days	463 (5.12)
ED visit, days from surgery (median, IQR)	7 (2–16)
Inpatient hospitalization within 30 days	155 (1.71)
Inpatient, days from surgery (median, IQR)	12 (5–20)
<b>Presenting diagnosis<sup>a)</sup></b>	
Urinary retention	356 (52.82)
Hematuria	78 (11.57)
UTI	78 (11.57)
Malfunctioning foley	266 (39.47)

ED, emergency department; IQR, interquartile range; UTI, urinary tract infection.

<sup>a)</sup> Remainder did not reach threshold.

Similarly, diabetes mellitus (OR 1.38, CI 1.06–1.81,  $P = 0.018$ ), congestive heart failure (OR 2.4, CI 1.02–5.75,  $P = 0.045$ ), ED visits within 180 days (OR 1.72, CI 1.49–1.99,  $P < 0.001$ ), and inpatient admission within 90 days (OR 3.45, CI 2.36–5.06,  $P < 0.001$ ) predicted the need for an ED or inpatient evaluation.

To determine independent predictors of hospital revisit within 30 days of brachytherapy, we fit a multivariable model with factors significant on univariable analysis (Table 3). The multivariate logistic regression model demonstrated that increasing patient age was associated with an increased risk of hospital-based medical evaluation. Patients aged 65–75 years had a 30% increased odds for a medical evaluation within 30 days of brachytherapy (OR 1.3, CI 1.06–1.60,  $P = 0.01$ ), while patients aged >75 years had a 50% (OR 1.5 CI 1.18–1.966,  $P = 0.001$ ) increased odds. Prior inpatient hospitalization within 90 days significantly increased the chances for a hospital-based medical evaluation within 30 days of brachytherapy (OR 2.68 CI 1.8–4.0,  $P < 0.001$ ) as well as prior ED visit within 180 days (OR 1.64 CI 1.4–1.9,  $P < 0.001$ ). None of the medical comorbidities or Charlson Comorbidity Index increased the risk for admission or ED visit. Interestingly, those of Asian descent were at higher risk for a hospital encounter within 30 days of our procedure of interest (OR 2.11, CI 1.5–2.9,  $P < 0.001$ ).

**Table 3**  
Logistic regression.

	Univariate analysis			Multivariate analysis		
	OR	95% CI	P	OR	95% CI	P
<b>Age (years)</b>						
<65 (Ref)						
65–75	1.36	1.11–1.66	0.003	1.3	1.06–1.60	0.01
>75	1.66	1.29–2.13	<0.001	1.5	1.18–1.97	0.001
<b>Race</b>						
Caucasian (Ref)						
African American	1.17	0.78–1.78	0.439	1.14	0.74–1.75	0.55
Hispanic	1.34	0.98–1.84	0.069	1.2	0.86–1.65	0.29
Asian	2.22	1.60–3.05	<0.001	2.11	1.5–2.9	<0.0001
Other/unknown	1.29	1.03–1.60	0.022	1.2	1.2–1.6	0.046
<b>Comorbidities</b>						
Diabetes mellitus	1.38	1.06–1.81	0.018	1.22	0.86–1.75	0.263
Congestive heart failure	2.4	1.02–5.75	0.045	2.2	0.89–5.58	0.086
Prior cerebral vascular accident	0.62	0.08–4.62	0.646	0.5	0.07–3.87	0.512
Prior myocardial infarction	1.6	0.98–2.69	0.610	1.6	0.9–2.9	0.107
Chronic lung disease	1.14	0.79–1.67	0.473	1.15	0.74–1.80	0.537
Chronic renal insufficiency	0.87	0.40–1.87	0.717	0.69	0.26–1.82	0.452
Peripheral vascular disease	0.94	0.29–3.02	0.916	0.76	0.22–2.59	0.660
Charlson Comorbidity Index, median (IQR)	1.13	1.00–1.29	0.057	1	0.81–1.24	0.991
<b>Prior hospital visit</b>						
Emergency department (within 180 days)	1.72	1.49–1.99	<0.001	1.63	1.4–1.89	<0.001
Inpatient hospitalization (within 90 days)	3.45	2.36–5.06	<0.001	2.71	1.82–4.02	<0.001

#### 4. Discussion

Our study using a large population-based database is the first to characterize the rates of short-term hospital revisits after prostate brachytherapy. A prior survey of 262 men who underwent prostate cancer treatment revealed that 24.8% of patients felt that side-effect profile was the primary consideration driving their treatment decision.<sup>12</sup> Of patients who underwent brachytherapy alone, 40% chose this option because of the perceived risks compared with other modalities. Potential complications of prostate cancer treatment clearly play a critical role in the shared decision-making process, yet to our knowledge, the rates of hospital revisits due to complications within the global period have not previously been published.

We found that the rate of rehospitalization, defined as either an emergency room visit or inpatient admission, within 30 days of prostate brachytherapy was 5.8%. The most common presenting diagnoses were urinary retention, malfunctioning of urethral catheter, hematuria, and UTI, all attributable to the index procedure. Independent predictors for a hospital revisit were older patient age—between 65 and 75 years or >75 years—and an inpatient admission within 90 days or ED visit within 180 days before the index surgery. Asian or other/unknown race was an additional predictor for readmission which may be related to the smaller demographic but warrants further consideration. Asian race, along with African American race, was recently shown to be a predictor for reoperation or readmission after intracranial aneurysm clipping.<sup>13</sup>

Our results draw attention to the significance of post-hospital syndrome, defined by Krumholz as a transient period of increased medical vulnerability after a hospital discharge.<sup>14</sup> Although the timeframe has not been defined, previous work studying outcomes of outpatient hernia repairs found that the 30-day risk of adverse events was significantly higher in patients hospitalized within 90 days leading up to surgery.<sup>15</sup> van Walraven et al<sup>16</sup> introduced the LACE index (Length of stay, Acuity of admission, Charlson comorbidity score, Emergency department use), a quantifiable assessment of risk of death or unplanned 30-day readmission after hospitalization; ED visits in the 180 days before admission are

included in the score. These risk factors will ultimately alert physicians to patient groups who are most vulnerable to postoperative hospitalizations and therefore who may benefit from thorough preoperative risk assessment.

The 5.8% revisit rate we found after prostate brachytherapy is consistent with rates previously reported among outpatient surgeries of other surgical specialties.<sup>17–19</sup> Within outpatient urological surgery, Hollingsworth et al examined outcomes among Medicare beneficiaries undergoing 22 common ambulatory procedures and found the rate of readmission within 30 days to be 7.5–8.7% depending on the type of index facility (hospital outpatient department, ambulatory surgery center, or office).<sup>17</sup> Their data also report increasing age and comorbidities as predictors of developing postoperative complications, supporting the idea that preoperative factors may help identify patients who are at greater risk for a rehospitalization. Compared to rates of 30-day complications after radical prostatectomy, which have been shown to be as high as 20.4%, brachytherapy still remains much less.<sup>20</sup>

Notably, the significance of 30-day readmissions continues to evolve within the context of the Hospital Readmissions Reduction Program as part of the Affordable Care Act which was implemented in October 2012. Changes by the current administration are still to be determined, but following that policy, hospital reimbursements were reduced for higher-than-expected 30-day readmissions for certain medical diagnoses. This policy began to expand to surgical procedures in 2015, starting with hip and total knee arthroplasties, followed by coronary bypass graft surgery in 2017.<sup>21</sup> At present, the Centers for Medicare and Medicaid Services is also developing a Hospital Visits after Outpatient Surgery measure, which will continue to place more attention towards preventing potential adverse events and unplanned hospital visits after outpatient surgery.<sup>22</sup>

Specific to prostate brachytherapy, outcomes research has largely focused on the procedure's long-term complications.<sup>5,9,23,24</sup> It is well known that brachytherapy shares many of the same side effects as both radical prostatectomy and external beam radiation, namely affecting urinary, erectile, or gastrointestinal systems. Benoit et al<sup>23</sup> analyzed the Medicare claims of 2,124 men who underwent prostate brachytherapy in the year 1991 to understand the long-term morbidity in a nationwide population. Within 3 years, 8.3% of men required a bladder outlet procedure at an average of 1.1 years after brachytherapy, 0.2% underwent placement of an artificial urinary sphincter, 8.4% were newly diagnosed with erectile dysfunction, and 0.3% required a colostomy for a diagnosis of prostatic-rectal fistulae, rectal ulcer, or radiation proctitis. Chen et al<sup>5</sup> collected similar data using the National Cancer Institute's Surveillance, Epidemiology, and End Results registries and their associated Medicare claims data between 1991 and 1999 and found the rates and nature of complication or invasive procedure within 2 years of primary brachytherapy to be 32.2% urinary, 17.2% erectile, and 18.0% bowel. A study analyzing the 5-year cumulative incidence of hospitalizations among 32,465 men treated with either radical prostatectomy or radiation therapy found that the most common reasons for hospitalization after radiation (all forms) were radiation proctitis (41.3%), genitourinary bleeding (14.3%), gastrointestinal bleeding (13.7%), followed by urinary obstruction (12.1%).<sup>25</sup>

In contrast, our study focuses on short-term complications requiring emergency room visits or inpatient admission, occurring within 30 days of undergoing brachytherapy. To our knowledge, these rates have not previously been reported in the literature. Each of the most common presenting diagnoses (urinary retention, hematuria, UTI, and urethral catheter malfunction) is a complication of the urinary tract, suggesting a practical target area where further efforts are needed to reduce hospitalization after brachytherapy.

For example, no randomized controlled trials have studied the optimal use of perioperative antibiotic prophylaxis for patients undergoing brachytherapy to prevent the occurrence of UTI or other infection. Alpha-blocker usage (e.g., type, duration, combination) continues to be an area of investigation to reduce the incidence of urinary retention and irritative symptoms after brachytherapy.<sup>26,27</sup>

There are limitations of this study related to the use of an administrative database, which relies on the accurate entry of diagnosis and procedure codes. Furthermore, these entries do not permit additional analysis of potentially contributory patient-level data including voiding symptoms scores, use of alpha-blockers, gland size, or radiation dose—factors which have previously been shown to affect postbrachytherapy morbidity.<sup>26,28–30</sup> Ambulatory clinic data are not available, leaving in-office evaluations for brachytherapy-associated complications unaccounted for. Our data, while benefitting from the large numbers of an administrative database, are reflective of the state of California only, where the patterns or practicality of visiting physician offices versus EDs may differ from others. However, the large cohort size included in the present study offers a population-based estimation of morbidity to establish expectations and to provide a snapshot of contemporary short-term outcomes. Furthermore, it is hospital-based encounters that are currently emphasized when considering the impact of readmissions on hospital reimbursement. Entry of prostate brachytherapy codes also do not distinguish between high-dose rate and low-dose rate brachytherapy. Differences in hospital revisits between these techniques have not yet been reported. Other variations in techniques and practice patterns are institution specific or provider specific and are unavailable for analysis.

## 5. Conclusions

Rehospitalization after prostate brachytherapy is accounted for by ED visits or inpatient admissions, occurring at a rate of 5.8%. The most common reasons for readmission are urinary retention, hematuria, malfunctioning of urethral catheter, and UTI. Independent risk factors for rehospitalization are advanced age and recent inpatient hospitalizations, identifying patients who may benefit from thorough preoperative risk assessment.

## Conflicts of interest

The authors declare no conflicts of interest.

## Appendix A. Supplementary data

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.prnil.2018.03.003>.

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