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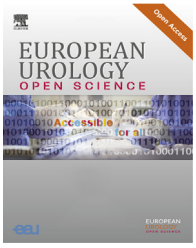


European Association of Urology

Prostate Cancer

# Disparities in the Delivery of Prostate Cancer Survivorship Care in the USA: A Claims-based Analysis of Urinary Adverse Events and Erectile Dysfunction Among Prostate Cancer Survivors

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**Abstract**

***Background and objective:*** Incidence rates for prostate cancer (PCa) diagnosis and mortality are higher for Black men. It is unknown whether similar disparities exist in survivorship care. We assessed the delivery and quality of survivorship care for Black men undergoing PCa therapy in terms of the burden of and treatment for urinary adverse events (UAEs) and erectile dysfunction (ED).

***Methods:*** We queried Optum Clinformatics data for all patients diagnosed with PCa from January 1, 2002 to December 31, 2017 and identified those who underwent primary PCa treatment. Index cohorts were identified in each year and followed longitudinally until 2017. Data for UAE diagnoses, UAE treatments, and ED treatments were analyzed in index cohorts. Cox proportional-hazards regression models were used to examine associations of race with UAE diagnosis, UAE treatment, and ED treatment.

***Key findings and limitations:*** We identified 146, 216 patients with a PCa diagnosis during the study period, of whom 55, 149 underwent primary PCa treatment. In the primary treatment group, 32.7% developed a UAE and 28.2% underwent UAE treatment. The most common UAEs were urinary incontinence (11%), ureteral obstruction/stricture (4.5%), bladder neck contracture (4.5%), and urethral stricture (3.7%). The most common UAE treatments were cystoscopy (13%), suprapubic tube placement (6%), and urethral dilation (5%). Overall, UAE diagnosis rates were higher for Black patients, who had significantly higher risk of urethral obstruction, rectourethral fistula, urinary incontinence, cystitis, urinary obstruction, and ureteral fistula. Overall, UAE treatment rates were lower for Black patients, who had significantly higher risk of fecal diversion and/or rectourethral fistula repair (adjusted

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hazard ratio [aHR] 1.71, 95% confidence interval [CI] 1.04–2.79). Regarding ED treatments, Black patients had higher risk of penile prosthesis placement (aHR 1.591, 95% CI 1.26–2.00) and intracavernosal injection (aHR 1.215, 95% CI 1.08–1.37).

***Conclusions and clinical implications:*** Despite a high UAE burden, treatment rates were low in a cohort with health insurance. Black patients had a higher UAE burden and lower UAE treatment rates. Multilevel interventions are needed to address this stark disparity. ED treatment rates were higher for Black patients.

***Patient summary:*** We reviewed data for patients treated for prostate cancer (PCa) and found that 32.7% were diagnosed with a urinary adverse event (UAE) following their PCa treatment. The overall treatment rate for these UAEs was 28.2%. Analysis by race showed that the UAE diagnosis rate was higher for Black patients, who were also more likely to receive treatment for erectile dysfunction.

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## 1. Introduction

There are more than 3 million prostate cancer (PCa) survivors in the USA [1]. Almost 100% of men with local or regional PC survive for 5 yr after their diagnosis; the relative 10-yr survival rate is 98% and the 15-yr survival rate is 96% [2]. Treatment for localized PCa is highly effective, but the side effects and impact on quality of life can be substantial. Treatment extends the quantity of life for PCa survivors, but data on the effects of PCa treatments on care delivery patterns and the quality of survivorship care are lacking [3]. Moreover, it is unknown if health disparities [4]—which are pervasive in PCa incidence, treatment, and mortality and disproportionately impact Black men [5–7]—persist in the PCa survivorship period.

Surgical and radiation urinary adverse events (UAEs) are common and costly adverse effects of treatment for localized PC and include urinary incontinence, urethral stricture, cystitis, rectourethral fistula (RUF), and bladder neck contracture, as well as erectile dysfunction (ED). UAEs and ED occur as a direct result of PC treatment and greatly impact health-related quality of life and have been linked to decisional regret for PCa survivors [8,9]. An understanding of the state and quality of the delivery of care in PCa survivorship, as well as any disparities, is essential for evidence-based solutions and interventions to ensure that all PCa survivors receive timely, high-quality, appropriate care as advocated for by the American Cancer Society and the Institute of Medicine [10]. We hypothesized that disparities exist in the delivery of PCa survivorship care for UAEs (including receipt of care for UAE and time to UAE treatment). These hypotheses are supported by research into disparities on PCa, which has demonstrated disparities in incidence, treatment, and mortality, as well as social, economic, and structural barriers that are pervasive for Black patients.

In the present study we analyzed UAE diagnosis, UAE treatment, time to UAE treatment, and ED treatment stratified by race in an insured cohort of patients who underwent definitive treatment for PCa. This approach yields findings that provide an insight into the quality of care for prostate cancer survivors. Assessment of the delivery of care for a cohort of insured patients allows an insight into disparities that exist for reasons other than insurance status, such as systemic and structural inequities.

## 2. Patients and methods

### 2.1. Data source

Optum Clinformatics Data Mart (OptumInsight, Eden Prairie, MN, USA) is a de-identified database of administrative health claims from more than 80 million commercially insured beneficiaries enrolled in private and Medicare Advantage health plans from a single payer. The database includes inpatient and outpatient claims for all insured individuals with both pharmacy and medical coverage throughout their enrollment on the insurance plan across all 50 states. As patient-level data are de-identified, the University of Michigan institutional review board deemed that ethical approval of the study was not required.

### 2.2. Sample selection

All patients with a PCa diagnosis from January 1, 2002 to December 31, 2017 were eligible for analysis. Patients with PCa were identified using International Classification of Disease (ICD)-9 and ICD-10 codes (Supplementary Table 1). We excluded men with <12 mo of continuous enrollment before the first diagnosis of PCa to ensure incident PCa diagnosis was captured. To ensure sufficient follow-up to identify and classify disease-free and treatment-free survival, we also excluded any patients with <12 mo of continuous enrollment after incident PCa diagnosis.

### 2.3. Identification of patients with primary PCa treatment

Primary PCa treatment was identified during the follow-up period using Current Procedural Terminology (CPT) codes (Supplementary Table 1). The first date of service in the follow-up period following index PCa diagnosis was calculated. Since patients could have multiple types of PCa treatments, the first discovery date for each of these treatments was calculated. Primary treatments included robotic and open radical prostatectomy (RP), external beam radiation

therapy (RT), brachytherapy, intensity-modulated RT, neutron beam treatment, proton beam treatment, stereotactic body RT, image-guided RT, and cryotherapy.

### 2.4. Identification of patients with UAEs

All UAE diagnoses were identified on the basis of empirical evidence from experienced physicians involved in the care of patients with UAEs and a priori literature [8,11–13]. UAE diagnoses were identified in Optum Clinformatics using ICD-9-CM and ICD-10-CM codes (Supplementary Table 1). To ensure that UAEs were not prevalent at the time of the incident PCa diagnosis, any patient with UAEs in the 12-mo period before their index PCa diagnosis were excluded. In the follow-up period, patients were identified for the first date that they had a UAE. Since patients could have multiple UAEs, the first date for each event was identified and the length of time in days from the index PCa treatment to each of the UAE first discovery dates was calculated. UAE diagnoses included urethral stricture, radiation cystitis, urinary incontinence, cystitis, RUF/urethral fistula, ureteral fistula, ureteral stricture, urinary tract/ureteral obstruction, urethral obstruction, and bladder neck contracture.

### 2.5. Identification of patients with UAE treatments

UAE treatments received by patients were identified using CPT codes (Supplementary Table 1) throughout their enrollment in the insurance plan. Given that diagnoses have limited validity in insurance claims [14], UAE treatments were examined for all patients who underwent PCa treatment. If a patient had more than UAE treatment, only the first date of discovery following primary PCa treatment was recorded and used to calculate the length of time in days from PCa treatment to the first UAE treatment. Given the variability in ICD coding, the first PCa treatment (and not PCa diagnosis) was used as the index procedure to determine the time to UAE treatment. The following UAE treatments were included: artificial urinary sphincter (placement, removal, removal/replacement), male sling (placement, revision), urethroplasty, perineal urethrostomy, urinary diversion, ileal ureter, ileovesicostomy, Mitrofanoff procedure, cystotomy/suprapubic tube placement, Foley catheterization, cystectomy/urinary diversion, cystoscopy, cystoscopy/clot evacuation, cystoscopy/bladder fulguration, cystoscopy/collagen injection/Botox injection, cystoscopy/biopsy transurethral resection of bladder tumor, cystoscopy/direct-vision internal urethrotomy, cystoscopy/calibration and/or dilation of urethral stricture or stenosis, meatotomy, incision/resection of bladder neck contracture, bladder neck closure, urethral stent placement, cystoscopy/steroid injection for stricture, urethral bulking, cystoscopy/ureteral stent placement, cystoscopy with stent placement/removal, ureteral meatotomy, endoscopy, ureteroneocystostomy, ureteral reconstruction, nephrostomy tube placement, transurethral resection of the prostate, transurethral incision of the prostate, pubectomy, split-thickness skin graft, urethrocutaneous fistula repair, fecal diversion for fistulas, closure of ureter or bowel fistula, and closure of rectovesical fistula or rectourethral fistula.

### 2.6. Identification of patients with treatment for ED

ED treatments received by patients were identified using CPT codes (Supplementary Table 1) throughout their enrollment in the insurance plan.

### 2.7. Exposure variable and other covariates

Covariates included age, race/ethnicity (self-reported), year of PCa diagnosis, US Census Bureau division, a composite Elixhauser comorbidity index [15], and each of the 31 comorbidities that comprise the comorbidity index. Race/ethnic group was the main exposure variable, with White representing the reference group.

### 2.8. Outcome variables

We analyzed four outcomes: (1) PCa diagnosis and treatment; (2) UAE among patients who underwent primary PCa treatment; (3) UAE treatment; and (4) time (in days) to UAE treatment.

### 2.9. Statistical analysis

We conducted bivariate analyses comparing demographic data and diagnosis and treatment rates among all race/ethnic groups. Subsequent bivariate analyses were conducted for patients with UAEs to compare baseline demographics and UAE treatments across race groups. All bivariate analyses for categorical variables were conducted using $\chi^2$ tests. Patient age was categorized so that no parametric or nonparametric testing was required. Age categories were defined using clinically relevant cutoffs.

To examine treatment-free survival for patients with a PCa diagnosis by race, Kaplan-Meier product-limit survival curves were plotted over a 3-yr follow-up period. We also plotted product-limit survival curves for (1) the time from PCa diagnosis to UAE diagnosis and (2) the time from UAE diagnosis to UAE secondary treatment for patients with PCa by race over a 3-yr period. Log-rank tests were used to examine if the proportional hazards assumption held true for the survival models. All patients were right-censored if they did not experience the relevant outcome in the follow-up period or if they discontinued their insurance plan.

To estimate the unadjusted and adjusted hazards of treatment-free survival (PCa diagnosis to PCa treatment), disease-free survival (PCa diagnosis to UAE diagnosis), and treatment-free survival (UAE diagnosis to UAE treatment), we developed a series of Cox proportional-hazards regression models. We constructed models for each of the UAE diagnoses and treatments, and for composite UAE diagnosis and treatment measures. To examine the unadjusted association between race and each of the outcomes, unadjusted Cox proportional-hazards models were fitted and unadjusted hazard ratios (HRs) and 95% confidence intervals (CIs) were calculated. Fully adjusted models were then fitted for the main exposure covariate (race) and adjusted HRs (aHRs) and 95% CIs were calculated. Models were adjusted for age group, race/ethnicity, year of PC diagnosis, US Census Bureau division, and Elixhauser comorbidity score.

All analyses were conducted using SAS v9.4 (SAS Institute, Cary, NC, USA). Statistical testing was two-tailed with a significance level of 0.05.

## 3. Results

### 3.1. Study cohort

We identified 146 216 patients with a PCa diagnosis from January 1, 2002, to December 31, 2017. The median enrollment time for the cohort was 2921 days (interquartile range 1886–4229) and the median follow-up after PCa treatment was 1070 days (interquartile range 571–1951). Of the 146, 216 patients with a PCa diagnosis, 55, 149 (37.7%) underwent 73, 545 treatments for PCa. The most common PCa treatments were RP and RT. As shown in Table 1, among the patients with a PCa diagnosis, 69.2% ($n$ = 101 124) were White, 9.3% ($n$ = 13 595) were Black, 8.5% ($n$ = 12 486) were Hispanic, and 2.2% ($n$ = 3244) were Asian. Among patients who underwent treatment, 71.4% ($n$ = 39 374) were White, 10.3% ($n$ = 5683) were Black, 7.1% ($n$ = 3907) were Hispanic, 1.9% ($n$ = 1027) were Asian, and 9.3% ($n$ = 5158) identified as "Other" or their race/ethnicity was unknown or missing.

The median age was 68 yr for White patients, 67 yr for Black patients, 70 yr for Hispanic patients, and 69 yr for Asian patients. The mean Elixhauser comorbidity index was 0.76 (standard deviation [SD] 1.0) for White patients, 0.86 (SD 1.1) for Black patients, 0.83 (SD 1.1) for Hispanic patients, 0.80 (SD 1.1) for Asian patients, and 0.77 (SD 1.1) for patients who identified as "Other" race/ethnicity, with a higher index corresponding to greater comorbidity.

**Table 1 – Clinical and demographic characteristics of the study cohort**

| Parameter | Result |
|---|---|
| Median age, yr (IQR) | |
| White | 68 (60–74) |
| Black | 67 (59–73) |
| Hispanic | 70 (62–75) |
| Asian | 69 (62–75) |
| Unknown/missing | 68 (61–73) |
| Race/ethnicity, *n* (%) | |
| White | 101 124 (69.2) |
| Black | 13 596 (9.3) |
| Hispanic | 12 486 (8.5) |
| Asian | 3244 (2.2) |
| Unknown/missing | 15 766 (10.8) |
| Year of prostate cancer diagnosis, *n* (%) | |
| 2002 | 5001 (3.4) |
| 2003 | 4460 (3.1) |
| 2004 | 5623 (3.9) |
| 2005 | 8400 (5.7) |
| 2006 | 6948 (4.8) |
| 2007 | 8458 (5.8) |
| 2008 | 12 497 (8.6) |
| 2009 | 10 189 (7.0) |
| 2010 | 8766 (6.0) |
| 2011 | 8723 (6.0) |
| 2012 | 8353 (5.7) |
| 2013 | 8896 (6.1) |
| 2014 | 8693 (6.0) |
| 2015 | 11 514 (7.9) |
| 2016 | 14 349 (9.8) |
| 2017 | 15 346 (10.5) |
| Primary treatment, *n* (%) | |
| Radical prostatectomy | 23 262 (31.2) |
| Intensity-modulated radiation therapy | 18 952 (25.8) |
| Primary androgen deprivation therapy | 11 828 (16.1) |
| Brachytherapy | 7910 (10.8) |
| External beam radiation therapy | 4879 (6.6) |
| Image-guided radiation therapy | 3967 (5.4) |
| Cryotherapy | 1845 (2.5) |
| Stereotactic body radiation therapy | 475 (0.7) |
| Proton beam treatment | 423 (0.6) |
| Mean Elixhauser comorbidity index (SD) | |
| White | 0.76 (1.0) |
| Black | 0.86 (1.1) |
| Hispanic | 0.83 (1.1) |
| Asian | 0.80 (1.1) |
| Unknown/missing | 0.77 (1.1) |

IQR = interquartile range; SD = standard deviation.

### 3.2. PCa treatment patterns

The most common PCa treatment was RP ($n$ = 23 262, 31.2%), followed by intensity-modulated radiation therapy ($n$ = 18 952, 25.8%) and primary androgen deprivation therapy (ADT; $n$ = 11 828, 16.1%; Table 1).

As shown in Table 2, the risk of undergoing RP was lower for Black patients (HR 0.83, 95% CI 0.80–0.87) and Hispanic patients (HR 0.59, 95% CI 0.56–0.63). Black patients also had higher risk of undergoing external beam RT (HR 1.05, 95% CI 0.95–1.15), brachytherapy (HR 1.38, 95% CI 1.29–1.47), intensity-modulated RT (HR 1.35, 95% CI 1.29–1.41), image-guided RT (HR 1.33, 95% CI 1.2–1.46), cryotherapy (HR 1.06, 95% CI 0.91–1.24), and primary ADT (HR 1.30, 95% CI 1.23–1.38). Hispanic patients had lower risk of undergoing most RT modalities except for intensity-modulated RT (HR 1.11, 95% CI 1.06–1.67).

### 3.3. UAE diagnosis and treatment patterns

#### 3.3.1. Unadjusted rates

As shown in Table 3, of 55 149 patients who underwent treatment for PCa, 38.0% ($n$ = 20 962) had a UAE diagnosis and 28.4% ($n$ = 15 680) underwent UAE treatment. Stratification of the distribution of UAE diagnoses by race revealed that the highest proportion was observed for Black patients (24.4%); 23.2% of White patients, 23.6% of Hispanic patients, and 23.8% of Asian patients had a UAE diagnosis. Regarding

**Table 2 – Unadjusted Cox hazard ratios for primary prostate cancer treatment by race/ethnicity, with White race as the reference**

| Prostate cancer treatment | Hazard ratio (95% confidence interval) | | |
|---|---|---|---|
| | Black | Hispanic | Asian |
| Radical prostatectomy | 0.83 (0.80–0.87)* | 0.59 (0.56–0.63)* | 0.76 (0.69–0.84)* |
| External beam RT | 1.05 (0.95–1.15) | 0.82 (0.73–0.91)* | 0.59 (0.46–0.75)* |
| Brachytherapy | 1.38 (1.29–1.47)* | 0.59 (0.53–0.65)* | 0.72 (0.60–0.85)* |
| Intensity-modulated RT | 1.35 (1.29–1.41)* | 1.11 (1.06–1.67)* | 0.95 (0.86–1.06) |
| Stereotactic body RT | 0.90 (0.66–1.24) | 0.76 (0.53–1.09) | 0.70 (0.35–1.42) |
| Image-guided RT | 1.33 (1.2–1.46)* | 1.0 (0.89–1.12) | 0.91 (0.73–1.15) |
| Cryotherapy | 1.06 (0.91–1.24) | 0.73 (0.61–0.88)* | 0.80 (0.57–0.81)* |
| Primary ADT | 1.30 (1.23–1.38)* | 0.92 (0.86–0.98)* | 0.77 (0.67–0.88)* |

ADT = androgen deprivation therapy; RT = radiation therapy.
* $p < 0.05$.

**Table 3 – Unadjusted UAE diagnosis and treatment rates by race[a]**

| Parameter | Patients, *n* (%) | | | | *p* value |
|---|---|---|---|---|---|
| | White | Black | Hispanic | Asian | |
| **UAE diagnosis** | | | | | |
| Urinary incontinence | 4531 (11.5) | 697 (12.3) | 462 (10.9) | 136 (13.2) | 0.0003 |
| Bladder neck contracture | 1828 (4.6) | 268 (4.7) | 268 (4.7) | 41 (4.0) | 0.04 |
| Urinary tract/ureteral obstruction[b] | 1789 (4.5) | 235 (4.1) | 201 (5.1) | 37 (3.6) | 0.02 |
| Urethral stricture | 1513 (3.8) | 201 (3.5) | 132 (3.4) | 39 (3.8) | 0.006 |
| Cystitis | 913 (2.3) | 188 (3.3) | 101 (2.6) | 20 (2.0) | <0.0001 |
| Urethral obstruction | 882 (2.2) | 152 (2.7) | 87 (2.2) | 24 (2.3) | 0.0008 |
| Ureteral fistula | 649 (1.7) | 121 (2.1) | 64 (1.6) | 16 (1.6) | 0.04 |
| Radiation cystitis | 611 (1.6) | 93 (1.6) | 79 (2.0) | 15 (1.5) | 0.20 |
| Ureteral stricture | 234 (0.6) | 21 (0.4) | 13 (0.3) | 2 (0.2) | 0.0009 |
| Rectourethral fistula | 103 (0.3) | 27 (0.5) | 8 (0.2) | 4(0.4) | 0.02 |
| Composite rate (%)[c] | 23.2 | 24.4 | 23.6 | 23.8 | – |
| **UAE treatment** | | | | | |
| Cystoscopy | 5077 (12.9) | 695 (12.2) | 462 (11.8) | 116 (11.3) | <0.0001 |
| Suprapubic tube | 2479 (6.3) | 352 (6.2) | 238 (6.1) | 77 (7.5) | 0.06 |
| Cystoscopy, direct-vision internal urethrotomy | 1909 (4.9) | 267 (4.7) | 170 (4.4) | 51 (5.0) | 0.007 |
| Transurethral resection of prostate/bladder neck | 569 (1.5) | 96 (1.7) | 57 (1.5) | 1 (0.1) | 0.03 |
| Male sling | 302 (0.8) | 46 (0.8) | 25 (0.6) | 7(0.7) | 0.62 |
| Artificial urinary sphincter | 259 (0.7) | 27 (0.5) | 17 (0.4) | 5 (0.5) | 0.25 |
| Cystectomy | 245 (0.6) | 12 (0.2) | 9 (0.2) | 2 (0.2) | <0.001 |
| Urethral stent | 191 (0.5) | 16 (0.3) | 12 (0.3) | 6 (0.6) | 0.01 |
| Nephrostomy tube | 161 (0.4) | 9 (0.2) | 12 (0.3) | 1 (0.1) | 0.01 |
| Split-thickness skin graft | 62 (0.2) | 1 (0.02) | 1 (0.03) | 0 | 0.01 |
| Fecal diversion | 87 (0.2) | 21 (0.4) | 10 (0.3) | 3 (0.3) | 0.17 |
| Cunningham clamp | 85 (0.2) | 4 (0.1) | 8 (0.2) | 2 (0.2) | 0.24 |
| Urethroplasty | 39 (0.1) | 2 (0.04) | 3 (0.1) | 0 | 0.51 |
| Urinary diversion | 52 (0.1) | 8 (0.1) | 3(0.1) | 0 | 0.64 |
| Ureteral reimplantation | 39 (0.1) | 6 (0.1) | 2 (0.1) | 1(0.1) | 0.89 |
| Cystoscopy, ureteral stent | 15(0.04) | 2(0.04) | 0 | 0 | 0.69 |
| Pubectomy | 5 (0.01) | 2 (0.04) | 1 (0.03) | 0 | 0.74 |
| Composite rate (%)[c] | 20.8 | 19.7 | 19.1 | 20.2 | – |

UAE = urinary adverse event.
[a] Race category "Other" not included in the table.
[b] Urinary tract/ureteral obstruction other than urethral stricture (eg, extrinsic compression, retroperitoneal fibrosis).
[c] The composite rates were calculated by combining all UAE diagnoses or treatments.

UAE treatments, Hispanic patients had the lowest treatment rate (19.1%), followed by Black (19.7%), Asian (20.2%), and White (20.8%) patients.

The most common UAE diagnoses were urinary incontinence (*n* = 6298, 30.0%), bladder neck contracture (*n* = 2501, 11.9%), urinary tract obstruction other than stricture (eg, retroperitoneal fibrosis; *n* = 2466, 4.5%), and urethral stricture (*n* = 2032, 3.7%). The least common diagnosis was RUF (*n* = 151, 0.3%; Table 3). Black and Asian patients had the highest rates of urinary incontinence (12% and 13%). Black patients had the highest rates of cystitis (3%), ureteral fistula (2%), rectourethral fistula (0.5%), and urethral obstruction (3%). White patients had the highest rates of urethral stricture (4%) and ureteral stricture (0.6%). Hispanic patients had the highest rate of urinary tract obstruction other than stricture (5%).

The most common UAE treatments were cystoscopy (including clot evacuation, bladder fulguration, collagen injection, and Botox injection; 13%), suprapubic tube placement (6%), direct-vision internal urethrotomy (including urethral dilation, meatotomy, bladder neck incision or resection; 5%), and transurethral resection of the prostate (including transurethral incision of the prostate and transurethral microwave therapy; 1.4%). An artificial urinary sphincter or a male sling was placed in 0.6% and 0.8% of patients, respectively. The least common UAE treatment was pubectomy (0.02%). The rate of artificial urinary sphincter placement was highest for White patients (0.7% vs 0.5% for Black, 0.4% for Hispanic, and 0.5% for Asian patients). White patients and Black patients underwent sling placement at the same rate (0.8%). Overall, 1.3% (*n* = 73) of Black patients and 1.4% (*n* = 561) of White patients underwent incontinence procedures.

### 3.3.2. *Unadjusted ED treatment rates*

We examined rates of penile prosthesis placement and intracavernosal injection for ED treatment. We found that 1.3% of White patients (*n* = 157) and 2.3% of Black patients (*n* = 42) received a penile prosthesis, and 4.6% of White patients (*n* = 551) and 6.4% of Black patients (*n* = 118) underwent intracavernosal injection.

### 3.3.3. *Cox regression results*

Among ten UAE diagnoses, Black patients had higher risk of seven (Table 4): urethral obstruction (adjusted HR [aHR] 1.26, 95% CI 1.05–1.50), radiation cystitis (aHR 1.03, 95% CI 0.82–1.28), urinary incontinence (aHR 1.12, 95% CI 1.04–1.22), cystitis (aHR 1.46, 95% CI 1.24–1.72), RUF (aHR 1.65, 95% CI 1.06–2.55), ureteral fistula (aHR 1.30, 95% CI 1.06–1.58), and bladder neck contracture (aHR 1.02, 95% CI 0.89–1.16). Overall, Black patients had a higher risk of UAE diagnosis in general (aHR 1.07, 95% CI 1.01–1.14). Table 4 also lists aHRs for UAE diagnosis and treatment for Hispanic and Asian patients. Asian patients had a lower

**Table 4 – Cox hazard ratios for UAE diagnosis and treatment by race/ethnicity, with White race as the reference**

| Parameter | Hazard ratio (95% confidence interval) | | | |
|---|---|---|---|---|
| | Unadjusted | Adjusted[a] | | |
| | Black | Black | Hispanic | Asian |
| **UAE diagnosis** | | | | |
| Urethral stricture | 0.94 (0.82–1.10) | 0.97 (0.84–1.13) | 0. 96 (0.80–1.15) | 0.91 (0.77–1.08) |
| Urethral obstruction | 1.24 (1.04–1.47)* | 1.26 (1.05–1.50)* | 0.93 (0.74–1.16) | 0.94 (0.62–1.41) |
| Radiation cystitis | 1.10 (0.88–1.37) | 1.03 (0.82–1.28) | 1.25 (0.98–1.59) | 0.89 (0.53–1.49) |
| Urinary incontinence | 1.10 (1.01–1.19)* | 1.12 (1.04,1.22)* | 0.95 (0.86–1.05) | 1.13 (0.95–1.34) |
| Cystitis | 1.48 (1.27–1.73)* | 1.46 (1.24–1.72)* | 1.08 (0.88–1.33) | 0.80 (0.51–1.26) |
| RUF | 1.87 (1.22–2.85)* | 1.65 (1.06–2.55)* | 0.85 (0.41–1.76) | 1.56 (0.57–4.28) |
| Ureteral stricture | 0.64 (0.41–1.0)* | 0.61 (0.39–0.96)* | 0.68 (0.38–1.19) | 0.41 (0.1–1.6) |
| Ureteral fistula | 1.35 (1.11–1.63)* | 1.30 (1.06–1.58)* | 0.91 (0.70–1.19) | 0.81 (0.49–1.33) |
| Ureteral obstruction | 0.94 (0.82–1.08) | 0.91 (0.79–1.07) | 1.00 (0.86–1.16) | 0.66 (0.47–0.91)* |
| Bladder neck contracture | 1.04 (0.92–1.18) | 1.02 (0.89–1.16) | 1.07 (0.91–1.26) | 0.99 (0.73–1.35) |
| UAE diagnosis composite[b] | 1.09 (1.03–1.16)* | 1.07 (1.01–1.14)* | – | – |
| **UAE treatment** | | | | |
| Artificial urinary sphincter | 0.75 (0.50–1.12) | 0.74 (0.49–1.11) | 0.69 (0.42–1.41) | 0.78 (0.32–1.90) |
| Male sling | 1.09 (0.80–1.49) | 1.13 (0.82–1.55) | 0.89 (0.59–1.35) | 0.91 (0.43–1.94) |
| Urethroplasty | 0.36 (0.09–1.50) | 0.31 (0.07–1.3) | 0.90 (0.28–2.98) | – |
| Cystoscopy, DVIU, BNI/D | 0.99 (0.87–1.13) | 0.99 (0.88–1.14) | 1.01 (0.86–1.18) | 1.16 (0.87–1.53) |
| Suprapubic tube | 1.00 (0.90–1.12) | 1.03 (0.92–1.16) | 0.92 (0.80–1.05) | 1.16 (0.93–1.46) |
| Urethral stent/SI/BA | 0.60 (0.36–1.00)* | 0.58 (0.35–0.97)* | 0.71 (0.39–1.28) | 1.34 (0.59–3.04) |
| TURP/TUMT/TUIP | 1.20 (0.97–1.50) | 1.24 (0.99–1.54) | 0.94 (0.72–1.25) | 1.21 (0.76–1.95) |
| Ureteral R/R | 1.08 (0.46–2.54) | 1.17 (0.48–2.86) | 0.45 (0.11–1.90) | 0.69 (0.09–5.08) |
| Urinary diversion | 1.08 (0.51–2.28) | 1.14 (0.53–2.46) | 0.63 (0.19–2.06) | – |
| Cystectomy, urinary diversion | 0.34 (0.19–0.61)* | 0.35 (0.19–0.62)* | 0.37 (0.19–0.72)* | 0.29 (0.07–1.19) |
| Ureteral stent | 0.95 (0.22–4.16) | 0.89 (0.20–4.05) | – | – |
| Nephrostomy tube | 0.40 (0.20–0.78)* | 0.43 (0.22–0.86)* | 0.80 (0.43–1.46) | 0.28 (0.04–2.00) |
| Fecal diversion, RUF repair | 1.66 (1.05–2.65)* | 1.71 (1.04–2.79)* | 1.05 (0.54–2.04) | 1.24 (0.39–3.98) |
| Split-thickness skin graft | 0.22 (0.05–0.88)* | 0.11 (0.02–0.78)* | 0.12 (0.02–0.84) | – |
| Cunningham clamp | 0.34 (0.12–0.92)* | 0.38 (0.14–1.03) | 1.04 (0.49–2.18) | 0.98 (0.24–4.03) |
| Pubectomy | 2.89 (0.56–14.88) | 3.3 (0.59–18.61) | 2.58 (0.26–26.13) | – |
| UAE treatment composite[b] | 0.97 (0.9–1.03) | 0.97 (0.91–1.04) | – | – |

BA = bulking agent; BNI/D = bladder neck incision/dilation; DVIU = direct-vision internal urethrotomy; R/R = reimplantation/reconstruction; RUF = rectourethral fistula; SI = steroid injection; TUIP = transurethral incision of the prostate; TURP = transurethral resection of the prostate; TUMT = transurethral microwave therapy; UAE = urinary adverse event

[a] Model adjusted for age group, race, year of prostate cancer diagnosis, US Census Bureau division, and Elixhauser comorbidity score

[b] The composite measures involved combining all UAE diagnoses or treatments.

* $p < 0.05$

risk of ureteral obstruction (aHR 0.66, 95% CI 0.47–0.91). Hispanic patients had a lower risk of cystectomy (aHR 0.37, 95% CI 0.19–0.72). No other UAE diagnoses or treatments reached statistical significance for Hispanic and Asian patients.

Regarding UAE treatments, Black patients had lower risk of urethral stent (aHR 0.58, 95% CI 0.35–0.97), cystectomy (aHR 0.35, 95% CI 0.19–0.62), nephrostomy tube (aHR 0.43, 95% CI 0.22–0.86), and split-thickness skin graft (aHR 0.11, 95% CI 0.02–0.78). Of the four UAE treatments with statistically significant HRs, Black patients had lower risk for three (urethral stent, cystectomy, nephrostomy tube). Black patients had a significantly higher risk of fecal diversion for RUF repair (aHR 1.71, 95% CI 1.04–2.79). Hispanic patients also had a lower risk of cystectomy (aHR 0.37, 95% CI 0.19–0.72).

Among ED treatments, Black patients had higher risk of penile prosthesis placement (aHR 1.591, 95% CI 1.26–2.00) and intracavernosal injection (aHR 1.215, 95% CI 1.08–1.37).

#### 3.3.4. *Time to UAE diagnosis and treatment*

Figure 1 shows Kaplan-Meier curves for the times from PCa treatment to UAE diagnosis and from PC treatment to UAE treatment. Black patients had the shortest time to UAE diagnosis, followed by Asian, Hispanic, and White patients. Asian and White patients had the shortest time to UAE treatment, followed by Black and Hispanic patients, who had the longest time from PCa treatment to UAE treatment.

## 4. Discussion

In this study examining the delivery of care for UAEs due to PCa treatment, one in three patients who were treated for PCa developed a UAE and approximately one in four underwent treatment for a UAE. We also identified stark disparities in the delivery of care for patients with UAEs: although the risk of UAE diagnosis was higher for Black patients, they had lower risk for UAE treatment. Hazard ratios for a penile prosthesis and intracavernosal injections for ED treatment were higher for Black patients. Of the six UAE diagnoses with statistically significant hazard ratios, the Black cohort had higher hazard ratios for five UAE diagnoses. Of the four 4 UAE treatments with statistically significant hazard ratios, the Black cohort had higher hazard ratio for one UAE treatment. To the best of our knowledge, this is the first study to identify this disparity in the delivery of care for UAEs among

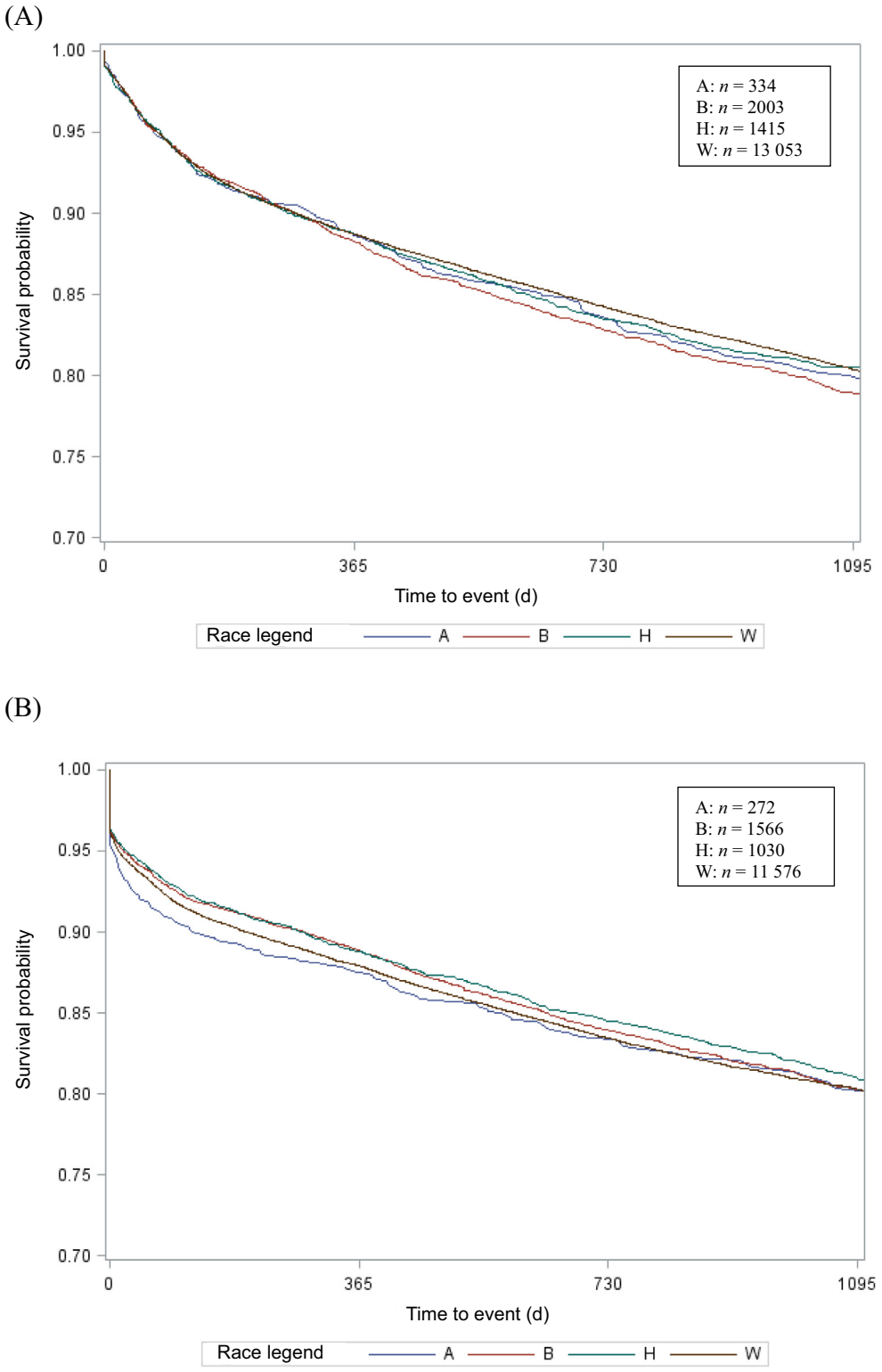


**Fig. 1 – Kaplan-Meier curves for time from prostate cancer treatment to (A) diagnosis and (B) treatment of urinary adverse events by race. A = Asian; B = Black; H = Hispanic; W = White.**

PCa survivors. Our study is notable because little is known about care delivery in PCa survivorship in general and we present data for a scenario in which patients have insurance. It is quite plausible that the disparity is worse in situations involving no access to care and/or no insurance [16]. Examining the delivery of care in a system with near-equitable access facilitates an insight into disparities that exist for reasons other than access to care and/or insurance by magnifying those that are secondary to systemic and structural barriers. Importantly, the identification and

recognition of such disparities may be essential to the examination of the quality of care in cancer survivorship, which has been a challenging metric [17]. Our findings apply a unique lens and launch point for understanding and addressing racial disparities in the delivery of care for PCa survivors.

The most common UAE in our study was urinary incontinence. While 11% of patients had urinary incontinence, only 1.4% underwent definitive treatment (artificial urinary sphincter or sling placement). Black patients had a higher rate of urinary incontinence, a lower rate of urinary sphincter placement, and the same rate of sling placement compared to White patients. A prior study evaluating data from an all-payer database over a period of 9 yr also revealed a low rate of artificial urinary sphincter placement (3.6%) in patients following RP [18]. In our insured cohort, the rate was even lower at 1.4%. It would have been plausible to have higher rather than lower rates in our study given that all patients had insurance. Our finding of a lower rate of artificial urinary sphincter placement and a lower rate of incontinence surgery overall for Black patients is supported by a study that assessed sling and artificial urinary sphincter placement in patients at a single institution [19]. The authors reported a rate of incontinence surgery of 3.7% and that incontinence procedures were less frequent for Black patients than for White patients, with a delay in treatment. The variation in urinary incontinence rates, with higher rates observed for Black patients, is supported by the CESAR study [20]. DeCastro et al. [21] reported worse urinary and sexual outcomes for Black patients at 12 mo after RP. This and our study suggest that rates of incontinence surgery should plausibly be higher for Black patients. Another important finding is that Black patients had higher risk of undergoing primary ADT as primary treatment for Pca, which is only recommended for men who are not candidates for curative therapy or have advanced PCa at diagnosis. This finding is corroborated in the literature [7].

Among all UAEs, the incidence and risk of rectourethral fistula, bowel diversion, and/or fistula repair were significantly higher for Black patients. Rectourethral fistulas can occur after RP, external beam RT, cryotherapy, brachytherapy, or combination therapy [22–26]. Rates of external beam RT and brachytherapy were higher for Black than for White patients in this cohort, which may explain the higher incidence of rectourethral fistulas, although this may not be the sole explanatory factor. The higher rectourethral fistula incidence may also reflect a lower quality of care received by Black patients. Although not directly examined in this study, research has demonstrated that Black and minority patients suffer from higher postoperative complication rates after adjustment for confounding factors [27,28]. This may also account for the higher rates of urinary incontinence for Black patients. The reasons for this disparity in the quality of care are multifactorial. One factor is the structural barriers that predispose Black patients to inequitable care and lower-quality hospitals. Another explanation may be unconscious bias, which can negatively affect health care outcomes [29].

The findings of this study should be considered in the context of several limitations. Our data lacks details on cancer severity and treatments that may affect sexual and urinary outcomes (eg, nerve-sparing RP can improve continence). It is plausible that Black patients have higher complication rates in this cohort because of higher-grade disease. However, if this were the case, Black patients should also have higher hazard ratios for UAE treatments. Our cohort was limited to individuals who underwent treatment for PCa, and it is unlikely that cancer severity data would have a major impact on our results. We also do not have severity data for UAE diagnoses, such as the severity of urinary incontinence (ie, pads per day). It is possible that only a few patients had worse urinary incontinence severity and were thus the patients who underwent treatment procedures for incontinence. Nevertheless, studies have demonstrated low rates of incontinence surgery when accounting for incontinence severity [19]. This probably reflects an area that can be improved. We do not have data on patient preferences for treatment. However, the high use of conservative treatments in this cohort probably reflects some provider influence. The use of diagnosis codes has limited validity in insurance claims; therefore, we also used CPT codes, which are validated for use in insurance claims. Our study also only has median follow-up to 3 yr after PCa treatment; it is likely that our UAE diagnosis and treatment rates are underestimates, as studies have shown higher incidence of UAEs at 10 yr [8]. In addition, although we did require continuous enrollment, it is possible that patients moved out of the dataset and subsequent treatments and complications including UAEs would not be included. We also acknowledge that this is not a comprehensive evaluation of ED treatments, as we do not examine the use of medication (e.g., phosphodiesterase inhibitors). We included an expansive list of UAE diagnoses and treatments, which may include diagnoses and treatments not related to PCa. However, we did establish the UAEs included in this study a priori, which increases the likelihood of their connection to PCa treatments. Each UAE treatment was not evaluated for direct correspondence to PCa treatment. Although we did observe low effect sizes for many of the unadjusted rates (Table 3), the hazard ratios provide more definitive conclusions of our findings. Although PCa treatment is highly associated with ED [30–32], we did not have data on evaluation of erectile function before treatment and our findings may not reflect the effects of treatment. Finally, we did not include medications that are widely used as first-line treatments for UAEs and ED in this report. We plan to include this treatment approach in future work.

These limitations notwithstanding, our findings have implications for patients, providers, and policymakers. For patients, our study highlights disparities in the delivery of PCa survivorship care. PC survivorship is a team effort, and multidisciplinary teams are key to ensuring that patients receive appropriate and timely care. Patients should be encouraged by their providers, including primary care physicians, oncologists, and urologists, to seek treatment for UAEs with the knowledge that UAE treatment may improve their quality of life. For providers, interventions targeting communication and mitigation of unconscious bias are key to progress. Unconscious bias has been linked to worse health outcomes and is a potentially modi-

fiable root of health care disparities [33,34]. For policymakers who are interested in quality metrics, delivery of care for PCa survivors who have developed a UAE is a potential quality metric for PCa survivorship that may prove to be more tangible for patients than survivorship care plans, which are another proposed but challenging quality metric [17].

## 5. Conclusions

Our study revealed disparities in PC survivorship that likely extend from the well-described disparities in PCa incidence and treatment. Although the Black patient population had higher UAE diagnosis rates, the UAE treatment rates were lower for this group. While PCa treatments increase the quantity of life and provide a viable cure, it is important to ensure that the quality of care that patients receive in the survivorship period is equitable. Future studies at multiple levels will be critical to identify specific areas for intervention and improvements in survivorship care.

***Author contributions:*** Nnenaya Mmonu had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

*Study concept and design*: Mmonu, Kamdar.
*Acquisition of data*: Mmonu, Kamdar.
*Analysis and interpretation of data*: Mmonu, Kamdar.
*Drafting of the manuscript*: Mmonu, Kamdar.
*Critical revision of the manuscript for important intellectual content*: Mmonu, Kamdar, Roach, Sarma, Makarov, Zabar, Breyer.
*Statistical analysis*: Kamdar.
*Obtaining funding*: Mmonu.
*Administrative, technical, or material support*: Mmonu.
*Supervision*: Mmonu, Breyer.
*Other*: None.

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## Appendix A. Supplementary data

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