

Smoking and Acute Urinary Retention: The Olmsted County Study of Urinary Symptoms and Health Status Among Men

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BACKGROUND. Previous reports have suggested an inverse relationship between smoking and surgery for benign prostatic hyperplasia (BPH). We hypothesized that acute urinary retention (AUR), an adverse outcome of this disease and indication for surgical treatment, may be related to smoking.

METHODS. Study subjects were randomly selected from Olmsted County men aged 40–79 identified through the Rochester Epidemiology Project. Of the 3,854 eligible men, 2,089 (54%) completed a questionnaire that included the American Urological Association Symptom Score and assessed smoking status. Community medical records were examined for occurrence of AUR with documented catheterization in the subsequent 10 years and occurrence of BPH surgery. Proportional hazard models were used to assess the relationship between baseline smoking status and subsequent retention.

RESULTS. In the 18,307 person-years of follow-up, 114 men had AUR. When compared to 727 never-smokers, there was a trend among the 336 current smokers to be at lower risk (Relative risk (RR) = 0.62, 95% Confidence Interval (CI) = 0.33, 1.18) whereas the 1,026 former smokers were at similar risk to non-smokers (RR = 1.0, 95% CI = 0.67, 1.46). Among men with moderate-severe symptoms at baseline, current smokers were at lower risk of retention compared to non-smokers (RR = 0.65, 95% CI = 0.22, 1.91) but the association approached the null among those with none-mild symptoms (RR = 0.91, 95% CI = 0.40, 2.06).

CONCLUSIONS. Community-dwelling men who currently smoke may be at a modestly reduced risk of AUR. The magnitude of this association is sufficiently small that it seems unlikely that this explains a sizable proportion of the inverse association between smoking and surgically treated BPH. *Prostate* 69: 699–705, 2009. © 2009 Wiley-Liss, Inc.

KEY WORDS: smoking; acute urinary retention; BPH; men; aging

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INTRODUCTION

Previous reports have suggested an inverse relationship between smoking and development of, or surgery for, benign prostatic hyperplasia (BPH) [1–3]. There has been a great deal of debate about whether or not this represents a cause and effect relationship. In fact, many have suggested that this inverse relationship may be due to a bias imposed by smokers being perceived as generally poorer surgical candidates, resulting in proportionately fewer procedures among smokers as compared to non-smokers [4,5]. However, smoking could affect risk of BPH through either neurologic or endocrine pathways [6]; either of these may affect a man's risk of acute urinary retention (AUR), often an indicator of advanced disease and trigger for surgical therapy [7,8]. We therefore hypothesized that an inverse relationship between smoking and AUR may be responsible for some portion of the inverse relationship between smoking and surgery for BPH. Thus the objective of this study was to test the hypothesis that smoking status is inversely related to the incidence of AUR. We accomplished this using data from a prospective cohort study conducted in the context of the Rochester Epidemiology Project (REP) [9].

MATERIALS AND METHODS

Study Subjects

The Olmsted County Study of Urinary Symptoms and Health Status among Men is a population-based, prospective cohort study initiated in December of 1989 to study the natural history of BPH. Many of the details of this study have been published previously [10]. Briefly, this study was designed to measure the age-specific prevalence of urinary symptoms in a community-based sample of men and to follow these men over time for the onset as well as progression or regression of disease.

Potential subjects included men aged 40–79 years who were residents of Olmsted County, Minnesota. The resources of the REP [9] were used to establish a sampling frame of Olmsted County residents. Men aged 40–79 years on January 1, 1990 were randomly selected within 5-year age groups and two geographic strata (city of Rochester vs. balance of Olmsted County) at a 14% sampling fraction. After screening a potential subject's medical history for exclusion and eligibility criteria, he was contacted and his participation in the study solicited. The exclusion criteria were established to remove men who had previously received surgical treatment for genitourinary conditions or had neurologic conditions thought to interfere with normal voiding. Of the 3,858 men identified as potentially eligible for study, a total of 2,115 men (55%) completed

the study protocol at baseline which included completion of a previously validated self-administered questionnaire [11] that included elements of lower urinary tract symptoms, health status, and several sociodemographic characteristics. Of the 2,115 men, 2,089 (99%) provided baseline information regarding smoking status and were included in the current analysis.

Follow-Up

Medical records of all study subjects at virtually all health care providers in Olmsted County were identified and reviewed. These records included information on all physician visits in the inpatient or outpatient settings, emergency room visits and home or nursing home visits. Follow-up was conducted from July 1992 to February 1996 and again from March 2000 to July 2002 by two trained nurse abstractors, providing a median follow-up time of 105 months (8.75 years) following completion of the baseline questionnaire. The study protocol for the baseline and follow-up investigations was approved by the Mayo Clinic Foundation and Olmsted Medical Center Institutional Review Boards.

Measurements

Twelve questions in the baseline questionnaire elicited information regarding frequency of specific urinary symptoms during the past month and were measured on a 7-point scale from 0 (I do not have symptoms) to 6 (always). A composite score for symptom frequency was calculated to approximate the American Urologic Association (AUA) symptom index for BPH by re-scaling our data in consultation with the AUA index developers [12]. Lower urinary tract symptom severity was then categorized as none to mild ($AUASI \leq 7$) and moderate to severe ($AUASI > 7$).

Smoking status was assessed by questionnaire at baseline. Men were categorized as "ever smokers" if they had ever smoked a total of 100 or more cigarettes in their lifetime, and "never smokers" if they had not. Ever smokers were categorized as former or current smokers based on their current smoking status. Number of packs smoked per day and pack-years of smoking were calculated for both former and current smokers. Smoking exposure for smokers was based on cigarette consumption at baseline and classified as light (0–1 pack/day), moderate (1–1.4 packs/day), and heavy (≥ 1.5 packs/day).

The occurrences of AUR and surgical BPH treatment were ascertained through review of the complete community medical records of each subject. A diagnosis of AUR was accepted only if there was documentation of urinary bladder catheterization

(transurethral or suprapubic) for acute retention. BPH treatment included surgical and minimally invasive procedures. For each subject the date of occurrence for the first episode of acute retention and the date of occurrence of the first surgical treatment were recorded.

Statistical Analysis

The distribution of baseline variables was compared by smoking status. The relative risk of AUR or surgical treatment associated with baseline variables was estimated using Cox proportional hazards models. Follow-up started on the date the baseline questionnaire was completed, and continued until the first occurrence of an event (AUR or surgical treatment) or the date of death or last documented clinic visit (censor). Models were constructed to estimate bivariate associations between baseline characteristics and the event, whereas multivariable models were constructed to estimate relative risks after adjustment for other baseline variables. Additional analyses were performed with different cut points for the continuous variables. These analyses yielded results of similar direction and magnitude, and only the results based on the above cut points are presented for simplicity. All analyses were performed using SAS Version 8.2 (Cary, NC).

RESULTS

Among the 2,089 men who participated in the study at baseline and had smoking status available, 336 (16%) reported being current smokers, 1,026 (49%) former smokers, and 727 (35%) reported having never smoked. (Table I) In addition, 1,391 of the 2,092 men with AUASI information available (66%) reported none to mild urinary symptoms at baseline and conversely 701 (34%) reported moderate to severe symptoms (AUASI > 7).

During the 18,307 person-years of follow-up, 114 men developed AUR (Table II). Of the men who never smoked, 5.9% developed AUR, as opposed to

TABLE I. Frequency (%) of Baseline Characteristics by Smoking Status, The Olmsted County Study of Urinary Symptoms and Health Status Among Men

Characteristics	Current smokers (n = 336)	Former smokers (n = 1,026)	Never smokers (n = 727)
Age (years)			
40–49	166 (49.4%)	323 (31.5%)	291 (40.0%)
50–59	91 (27.1%)	296 (28.9%)	218 (30.0%)
60–69	57 (17.0%)	246 (24.0%)	134 (18.4%)
70+	22 (6.6%)	161 (15.7%)	84 (11.6%)
AUA symptom score			
≤7	242 (71.8%)	669 (65.1%)	480 (65.9%)
>7	95 (28.2%)	358 (34.9%)	248 (34.1%)
Prostate volume			
≤30	62 (75.6%)	173 (60.7%)	141 (65.0%)
>30	20 (24.4%)	112 (39.3%)	76 (35.0%)
Q _{max}			
≥12	304 (90.5%)	801 (78.1%)	548 (75.5%)
<12	32 (9.5%)	225 (21.9%)	178 (24.5%)
Hypertension			
No	286 (84.9%)	784 (77.0%)	586 (80.6%)
Yes	51 (15.1%)	234 (23.0%)	141 (19.4%)
Diabetes			
No	323 (95.9%)	966 (94.1%)	698 (95.9%)
Yes	14 (4.2%)	61 (5.9%)	30 (4.1%)

only 3.6% of current smokers. When compared to the 726 never-smokers, there was a trend among the 333 current smokers to be at lower risk in crude analyses (Relative risk (RR) = 0.62, 95% Confidence Interval (CI) = 0.33, 1.18) whereas the 1,023 former smokers were at similar risk to non-smokers (RR = 1.0, 95% CI = 0.67, 1.46).

The inverse association between smoking and AUR strengthened in a dose-response fashion by pack-years of smoking. Men who smoked for 1–20 years had an age-adjusted RR of 0.96 [95% CI (0.61–1.51)], and men who smoked more than 20 years had an age-adjusted RR of 0.76 [95% CI (0.49–1.20)] (Table III).

TABLE II. Crude and Age-Adjusted Association of Acute Urinary Retention With Baseline Smoking Status

Smoking status	Acute urinary retention				Relative risks			
	Yes		No		Crude		Age-adjusted	
	n ^a	%	n ^a	%	RR	95% CI	RR	95% CI
Never	43	5.9	683	94.1	1.0	—	1.0	—
Former	59	5.8	964	94.2	1.0	0.67–1.46	0.88	0.59–1.31
Current	12	3.6	321	96.4	0.62	0.33–1.18	0.78	0.41–1.49

RR, relative risk; CI, confidence interval.

^aColumn totals do not add to 2,089 due to missing data.

TABLE III. Crude and Age-Adjusted Association of Acute Urinary Retention With Pack-Years of Smoking at Baseline

Smoking (pack years)	Acute urinary retention				Relative risks			
	Yes		No		Crude		Age-adjusted	
	n ^a	%	n ^a	%	RR	95% CI	RR	95% CI
0	43	5.9	684	94.1	1.0	—	1.0	—
1–20	34	5.4	596	94.6	0.92	0.59–1.44	0.96	0.61–1.51
>20	34	5.0	648	95.0	0.86	0.55–1.35	0.76	0.49–1.20

RR, relative risk; CI, confidence interval.

^aColumn totals do not add to 2,089 due to missing data.

While current smokers also appeared to have a decreased risk of surgical treatment in unadjusted analyses (RR = 0.59, 95%CI = 0.34, 1.02) as compared to never smokers, the results did not reach statistical significance (Table IV). Former smokers were at a similar risk to non-smokers (RR = 1.10, 95%CI = 0.79, 1.51). However, no dose-response trend with pack-years of smoking was observed (Table V).

Among men with none to mild urinary symptoms at baseline, both former and current smokers were somewhat less likely to develop AUR as compared to never smokers, with age-adjusted RRs of 0.71 [95% CI (0.39–1.28)] and 0.91 [95% CI (0.40–2.06)], respectively (Table VI). Among men who reported moderate to severe urinary symptoms at baseline, current smokers had a decreased risk with an age-adjusted RR of 0.65 [95% CI (0.22–1.91)]. Former smokers, however, were at similar risk compared to never smokers, with a RR of 1.04 [95% CI (0.61–1.78)]. The test for interaction between smoking status and symptom severity was not significant ($P = 0.33$, data not shown).

Similarly, among men with none to mild urinary symptoms at baseline, current smokers were less likely undergo surgical treatment as compared to never smokers, with an age-adjusted RR of 0.80 [95% CI (0.36–1.80)] albeit these results were not statistically significant (Table VII). Among men who reported

moderate to severe urinary symptoms at baseline, current smokers had a decreased risk with an age-adjusted RR of 0.71 [95% CI (0.33–1.52)]. While former smokers with none to mild urinary symptoms at baseline were at a slightly elevated risk of surgical treatment as compared to never smokers (RR = 1.27, 95%CI = 0.78, 2.08) in age-adjusted analyses, former smokers with moderate to severe symptoms were at decreased risk of surgical treatment (RR = 0.76, 95%CI = 0.49, 1.17).

DISCUSSION

The objective of this study was to test the hypothesis that smoking status is inversely related to the incidence of AUR. Overall, these data demonstrate a trend towards a lower risk of acute urinary retention among current smokers as compared to never-smokers that was not evident for former smokers. This inverse association appeared to be more apparent among men who reported greater lower urinary tract symptom severity at baseline, who were at two-to-three times the risk of AUR. The trend was similar by pack-years of smoking at baseline.

In a previous study of this population we found that AUR was associated with lower urinary tract symptom severity. Overall, men with moderate to

TABLE IV. Crude and Age-Adjusted Association of Surgical Treatment With Baseline Smoking Status

Smoking status	Surgery				Relative risks			
	Yes		No		Crude		Age-adjusted	
	n ^a	%	n ^a	%	RR	95% CI	RR	95% CI
Never	74	10.0	665	90.0	1.0	—	1.0	—
Former	101	9.8	930	90.2	1.10	0.79–1.51	0.96	0.69–1.32
Current	18	5.4	317	94.6	0.59	0.34–1.02	0.70	0.40–1.21

RR, relative risk; CI, confidence interval.

^aColumn totals do not add to 2,089 due to missing data.

TABLE V. Crude and Age-Adjusted Association of Surgical Treatment With Pack-Years of Smoking at Baseline

Smoking (pack years)	Surgery				Relative risks			
	Yes		No		Crude		Age-adjusted	
	n ^a	%	n ^a	%	RR	95% CI	RR	95% CI
0	74	10.0	666	90.0	1.0	—	1.0	—
1–20	49	7.8	583	92.2	0.89	0.61–1.31	0.91	0.62–1.34
>20	69	10.0	621	90.0	1.10	0.77–1.56	0.94	0.66–1.34

RR, relative risk; CI, confidence interval.

^aColumn totals do not add to 2,089 due to missing data.

severe symptoms were at a threefold increased risk of AUR compared to men with no to mild symptoms [13]. These results suggested that the cut point suggested for considering treatment options for BPH in the Agency for Health Care Policy and Research (AHCPR) diagnostic and treatment guidelines [14], provides some level of discrimination between those who are more likely to develop retention and those who do not. In this same cohort, we found that compared to never smokers, current smokers were less likely to have moderate to severe urinary symptoms [15]. This has been observed in other settings as well [16,17]. Consequently, if smokers are less likely to develop moderate to severe LUTS, the risk for subsequent AUR potentially decreases as suggested by the previous study described above. This is supported by our findings in the current report as we found smoking to be inversely related to AUR and this inverse association was enhanced in men who reported moderate to severe LUTS.

In this community setting, men who currently smoke may be at a modestly reduced risk of AUR. The magnitude of this association is sufficiently small that it seems unlikely that this explains a sizable

proportion of the inverse association between smoking and surgically treated BPH. Nearly half of all episodes of acute urinary retention in this cohort were associated with surgical procedures, and nearly 90% of these were performed with the patient under general anesthesia. Only 14% of persons with an incident event subsequently underwent transurethral resection of the prostate and only 1 subject experienced subsequent episodes of retention. While the number of cases is small, these data suggest that some factor associated with general anesthesia, either pharmacological, physiological or traumatic, may have a precipitating role in a large proportion of cases of AUR in the community.

When interpreting these data, several potential limitations must be considered. Follow-up was limited to the information recorded in the community medical records. However, AUR is a condition that is likely to come to medical attention and recorded in the medical records, even if not assigned a diagnostic code. In addition, prior studies have observed that patterns of tobacco use tend to be under-reported [18,19]. The small percentage of smokers (16%) in this study appears disproportionately low and may imply a non-representative study sample, misclassification of

TABLE VI. Crude and Age-Adjusted Association of Acute Urinary Retention With Baseline Smoking Status, Stratified by Baseline Symptom Status

Smoking status	AUR, n (%)	Baseline symptom severity								
		None-mild symptoms (AUASS ≤ 7)				Moderate-severe symptoms (AUASS > 7)				
		Crude		Age-adjusted		Crude		Age-adjusted		
RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI			
Never	22 (4.6)	1.0	—	1.0	—	21 (8.5)	1.0	—	1.0	—
Former	23 (3.4)	0.75	0.42–1.34	0.71	0.39–1.28	36 (5.2)	1.23	0.72–2.11	1.04	0.61–1.78
Current	8 (0.6)	0.74	0.33–1.66	0.91	0.40–2.06	4 (0.6)	0.53	0.18–1.54	0.65	0.22–1.91

RR, relative risk; CI, confidence interval.

TABLE VII. Crude and Age-Adjusted Association of Surgical Treatment With Baseline Smoking Status, Stratified by Baseline Symptom Status

Smoking status	Baseline symptom severity									
	None-mild symptoms (AUASS \leq 7)					Moderate-severe symptoms (AUASS $>$ 7)				
	AUR, n (%)	Crude		Age-adjusted		AUR, n (%)	Crude		Age-adjusted	
RR		95% CI	RR	95% CI	RR		95% CI	RR	95% CI	
Never	24 (5.0)	1.0	—	1.0	—	37 (15.0)	1.0	—	1.0	—
Former	47 (7.0)	1.42	0.87–2.32	1.27	0.78–2.08	46 (13.0)	0.87	0.56–1.34	0.76	0.49–1.17
Current	8 (0.6)	0.69	0.31–1.54	0.80	0.36–1.80	8 (8.7)	0.60	0.28–1.29	0.71	0.33–1.52

RR, relative risk; CI, confidence interval.

exposure or low smoking rates in the source population. It is unlikely, however, that any of these potential biases are related to retention status; therefore estimates of the associations between smoking and AUR would most likely be unaffected or biased towards the null. Furthermore, smoking was assessed in this study at baseline and thus does not reflect changes in smoking over the course of the study. In addition, the associations suggest an inverse relationship between smoking and AUR but the interval estimates included the null hypotheses and therefore the results could have occurred by chance alone. Even if the association is real, the apparent effect of cigarette smoking may be due to some other unhealthy behavior/risk factor not measured.

Finally, there may be limitations to the generalizability of these findings. Residents of Olmsted County tend to be well insured [9] which could lead to the opportunity for earlier intervention that might prevent later complications such as AUR. Furthermore, the effects of being included in this study may increase subject awareness, increase the opportunity for intervention and, thereby, decrease the chance of these late complications. In balance, the local practice has been viewed as conservative, probably because of the proximity to healthcare providers and ability to intervene in emergency situations. In fact, transurethral resection of the prostate rates for Olmsted County have traditionally been lower than for the rest of the country [20]. Along these same lines, the initial participation rate and baseline exclusion criteria may have influenced the generalizability of the findings. However, in a previous study, we found little difference in rates of AUR between participants and non-participants [13]. This suggests that slight systematic differences in baseline composition of the cohort may not have had as great an influence in subsequent follow-up. Finally, because these results are based on white men,

extrapolation of findings to other races or settings may not be appropriate.

CONCLUSIONS

In a community setting, men who currently smoke may be at a modestly reduced risk of acute urinary retention. The magnitude of this association is sufficiently small that it seems unlikely that this explains a sizable proportion of the inverse association between smoking and surgically treated BPH.

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