Received: 19 February 2018 | Accepted: 8 May 2018
DOI: 10.1002/nau.23719

ORIGINAL CLINICAL ARTICLE

WILEY Neurourology Urodynamics ICS SUFU

Association between overactive bladder treatment and falls among older adults

Ravishankar Jayadevappa PhD[1,2,3,4,5] | **Sumedha Chhatre PhD**[5] | **Diane K. Newman DNP**[3] | **Jerome Sanford Schwartz MD**[1] | **Alan J. Wein MD, PhD(Hons)**[3]

[1] Department of Medicine, Perelman School of Medicine, University of Pennsylvania, Philadelphia, Pennsylvania

[2] Leonard Davis Institute of Health Economics, University of Pennsylvania, Philadelphia, Pennsylvania

[3] Division of Urology, Department of Surgery, Perelman School of Medicine, University of Pennsylvania, Philadelphia, Pennsylvania

[4] Corporal Michael J. Crescenz VAMC, Philadelphia, Pennsylvania

[5] Department of Psychiatry, Perelman School of Medicine, University of Pennsylvania, Philadelphia, Pennsylvania

Correspondence
Ravishankar Jayadevappa, PhD, Perelman School of Medicine, Department of Medicine, University of Pennsylvania, 3615 Chestnut St Suite 224, Philadelphia, PA 19104.
Email: jravi@pennmedicine.upenn.edu

Funding information
Agency for Healthcare Research and Quality, Grant number: 1R01HS024106-01

Aims: To analyze the risk of falls associated with Overactive bladder (OAB), and the effects of OAB treatment on falls among older adult Medicare fee-for-service enrollees.
Methods: Population based retrospective longitudinal cohort design study using 5% Medicare claims between 2006 and 2010. Patients with a diagnosis of OAB (ICD 9: 596.51); Urinary Incontinence (ICD 9: 788.3); Urinary incontinence, unspecified (ICD 9: 788.30); Urge incontinence (ICD 9: 788.31); Mixed incontinence (male, female) (ICD 9: 788.33); Urinary frequency (ICD 9: 788.41); Nocturia (ICD 9: 788.43); or Urgency of urination (ICD 9: 788.63) were identified and followed retrospectively for 2 years. Falls was the main outcome of the study. Using logistic regressions, we analyzed the association between OAB and falls; and the protective effect of OAB treatment on falls. Propensity score and instrumental variable were used to minimize bias.
Results: We identified 33 631 Medicare enrollees (mean age = 77.8 years, sd = 7.6) with OAB. Higher proportion of OAB patients had falls, compared to those without OAB (11% vs 7%, $P < 0.001$). Diagnosis of OAB was associated with higher odds of falls (OR = 1.59; 95% CI = 1.53, 1.65) compared to those without OAB. Fourteen percent of OAB patients received OAB treatment. Treatment for OAB was associated with lower odds of falls (OR = 0.88; 95% CI = 0.80, 0.98) compared to those OAB patients who were not treated.
Conclusions: Older adults with OAB experience increased risk of falls. Treatment for OAB may reduce this risk. These findings emphasize the need to effectively identify and treat OAB in older adults.

KEYWORDS
falls, older adults, overactive bladder (OAB), treatment

1 | INTRODUCTION

Overactive bladder (OAB), defined by the International Continence Society (ICS) as urgency, with or without urge urinary incontinence (UI), frequently accompanied with frequency and nocturia in the absence of proven infection or other obvious pathology,[1,2] is a common health concern for women and men of all ages. An often embarrassing and

Hashim Hashim led the peer-review process as the Associate Editor responsible for the paper.

 © 2018 Wiley Periodicals, Inc.

debilitating condition with significant public health and economic consequences, OAB affects approximately 17% of women and 16% of men in the United States, and is especially common among the older adults.[1,3–6] Care for OAB has evolved from a relatively straightforward mono-therapy model to a complex one with multi-modal treatment options.[7] Moreover, studies of the outcomes of OAB treatment have demonstrated deficiencies and variability in the quality of OAB care across geographic region, age, and racial/ethnic groups.[5,6]

Overactive bladder has important implications as reflected by its effects on health related quality of life, functional status, health service use, and cost of care.[8–12] Falls are disproportionately common in the older adult population, and among patients with OAB, falls may be an unidentified factor in the variability in OAB care, contributing to impaired outcomes. Falls among OAB patients are linked to unpleasant lifestyle changes, poorer adherence to treatment, and worse long-term outcomes.[4,13–15] Some of the established risk factors for falls are old age, female gender, visual disturbance, cognitive disorder, and low body mass index.[4,13–15] Additional risk factors for falls are voiding symptoms of OAB, including urgency and urge incontinence, and nocturia.[10] Prior studies have highlighted the under-diagnosis and under-treatment of OAB among older adults with falls.[6,8,10,12] Despite the troubling effects of falls among OAB patients, the scope of the problem remains mostly underappreciated.[13] Additionally, few studies have used national samples to study the prevalence of falls among patients with OAB and the association between OAB and falls among older adults.[6,8,10–12] The objective of this study was to determine the association between an OAB diagnosis and falls among older adult Medicare fee-for service enrollees and, the protective effects of OAB treatment on risk of falls, if any. We hypothesized that persons with an OAB diagnosis have higher risk of falls, and treatment for OAB is associated with lower risk of falls, even after adjusting for potentially influential personal and clinical characteristics.

2 | MATERIALS AND METHODS

2.1 | Data source and sample selection

The Medicare 5% data provides Medicare administrative claims data for fee-for-service Medicare recipients. We used this data to create a cohort of men and women, aged 66 years and older, and identified those with a claim for OAB diagnosis between 2007 and 2008[16,17] (Supporting Information, appendix Table SA1 for a complete list of OAB related ICD-9 diagnosis codes). We excluded patients who had diagnosis of OAB in the year 2006. We created an index-date as following: for the OAB group, the date of first claim related to OAB diagnosis was the index date. For the non-OAB group, the earliest claim date between 2007 and 2008 was the index date. We used claims for 1-year prior to and 2 years post index-date. The cohort selection process is depicted in Supporting Information, appendix Figure SA1. The local Institutional Review Board approved this study.

2.2 | Measurement strategy

2.2.1 | Key dependent variable—Falls

Falls within 2 years post index-date was the main dependent variable in our analyses. We used diagnostic codes from Medicare inpatient, outpatient, and provider claims to identify falls among our OAB and non-OAB groups (Supporting Information, appendix Table SA2).

2.2.2 | Covariates

Data on demographic characteristics, medical co-morbidity, prior history of falls (1-year prior to index-date), and treatment for OAB were used to adjust for our measures of association between dependent variable (falls) and independent variables of OAB diagnosis and OAB treatment. We obtained data on age, race/ethnicity, sex, and geographic area from the Medicare denominator file. Charlson co-morbidity index was calculated using inpatient, outpatient, and provider claims from 1-year period prior to index-date.[18] Treatments for OAB were identified as pharmacological, surgical, or both (see Supporting Information, appendix Tables S3A, S4A, and S5A for medication list, diagnostic codes, and procedure codes).

2.3 | Analytic strategy

We tested for the underlying differences in the demographic and clinical characteristics of patients with and without OAB, using standard t tests and x^2 tests. We then analyzed the association between diagnosis of OAB and falls using unadjusted and adjusted models (adjusted for age, race/ethnicity, sex, geographic area, prior-falls, and Charlson co-morbidity). For the OAB group only, we studied the association between OAB treatment and falls using three models. Model 1 estimated the unadjusted association between OAB treatment and falls. While assessing the association between OAB treatment and falls, it is important to acknowledge that treatment assignment is not random. Therefore, for the OAB group, we used a two-stage propensity score technique for controlling the observed confounders. To begin with, using logistic regression, we estimated for each patient in our OAB group, the probability or propensity of receiving OAB treatment after accounting for age, race/ethnicity, gender, geographic area, prior falls, and Charlson co-morbidity score. Next, in Model 2, we modeled the associations between OAB treatment receipt

and falls, and weighted it by the inverse probability of treatment obtained from the propensity score. Finally, for our Model 3, we employed the economic technique of instrumental variable approach to address the unmeasured bias. An appropriate instrument is one that is associated with the exposure (OAB treatment), but not with the outcome (falls). It is possible that OAB treatment is offered more frequently in certain regions, and therefore patients from these regions may be more likely to receive treatment for OAB. Therefore, for each hospital referral region (HRR) in our study, we determined the proportion of OAB patients who received OAB treatment. Next, we categorized the HRR regions as high or low treatment regions using the median as cutoff, and used this variable as an instrument. Several steps were taken to evaluate the choice of instrument, the first being strength of the instrument using an F statistic. The F statistic of a strong instrument must be larger than 10 (our F statistic had a value of 173). We also used the Durbin-Wu-Hausman test of endogeneity to ensure that instrumental variable approach was essential for our model.

We used Statistical Analysis System (SAS), Version 9.3 (SAS Institute, Cary, NC) for analysis.

3 | RESULTS

3.1 | Sample characteristics

Total 284 625 persons with an inpatient, outpatient, or provider claim between 2007 and 2008 met our criteria of age (≥66 years of age) and with no diagnosis of OAB in year 2006. Of these, 33 631 had a claim for OAB diagnosis between 2007 and 2008. Additionally, 4458 patients from the OAB group received treatment for OAB. Supporting Information, appendix Figure SA1 presents the details of the cohort determination process.

Table 1 shows the comparison of non-OAB and OAB groups. Persons with an OAB diagnosis were older compared with those without an OAB diagnosis (mean age 77.8 years, std = 7.6 years vs mean age 76.6 years, sd. = 7.5; P-value <0.0001). Patients from the OAB group had higher medical co-morbidity, compared to those without OAB (46% vs 33%). The geographic distribution was mostly comparable between those with and without OAB. Higher proportion from OAB group were male, compared to the non-OAB group (43% vs 37 %; $P < 0.0001$). Eleven percent of the OAB group, and 7% of the non-OAB group had falls within 2 years after index-date ($P < 0.0001$).

3.2 | OAB diagnosis and risk of falls

As shown in Table 3, compared to the no-OAB group, a diagnosis of OAB was associated with higher odds of a fall (OR = 1.70, 95% CI = 1.64, 1.77), in the unadjusted logistic regression model. The odds of fall reduced to 1.59 (CI = 1.53, 1.65) after adjusting for demographic variables, co-morbidity, and history of prior falls.

TABLE 1 Personal and clinical characteristics of Medicare fee for service beneficiaries 66 years or older from 5% Medicare date between 2007 and 2008, by overactive bladder (OAB) status

	No OAB ($n = 250\,994$)	OAB ($n = 33\,631$)
Age at diagnosis (years)[a]		
Mean (s.d.)	76.6 (7.5)	77.8 (7.6)
Ethnicity (%)[a]		
White	201 299 (80.2)	27 951 (83.1)
African American	21 135 (8.4)	2303 (6.7)
Asian	12 683 (5.1)	1584 (4.7)
Hispanic	7729 (3.1)	923 (2.7)
Other	8148 (3.3)	870 (2.6)
Geographic area (%)[a]		
Metro	208 196 (83.5)	28 219 (84.0)
Urban	36 178 (14.5)	4747 (14.1)
Rural	4969 (1.9)	609 (1.8)
Charlson comorbidity index (%)[a]		
0	169 376 (67.5)	18 166 (54.0)
1-2	66 172 (26.4)	11 879 (35.3)
≥3	15 446 (6.2)	3586 (10.7)
Gender (%)[a]		
Male	91 759 (36.6)	14 339 (42.6)
Female	159 235 (63.4)	19 292 (57.4)
Falls (%)[a]		
Within 2 years of index date	17 444 (6.9)	3809 (11.3)
Treatment (%)		
Treatment		4558 (13.6)
No treatment		29 073 (86.4)

[a]All P-values are <0.05.

3.3 | OAB diagnosis and treatment

Among the OAB group, 13.6% had received treatment for OAB. In Table 2, we present a comparison of OAB patients with and without treatment for OAB. Compared to the no-treatment group, the treatment group had higher proportion of female gender, Asian and Hispanic ethnicity, non-metro areas, and one or more co-morbidity. Both groups had comparable age and proportion with falls in the 2-year post index-date period. The propensity score weighted comparison (Table 2) indicated that except for falls, other variables were not different between groups.

TABLE 2 Comparison of baseline characteristics before and after propensity score weighting for overactive bladder (OAB) cohort

	Unadjusted			Weighted		
	No treatment ($n = 29\,073$)	Treated ($n = 4558$)	*P*-value	No treatment ($n = 28\,225$)	Treated ($n = 5406$)	*P*-value
Age at diagnosis (years)						
Years, mean (s.d.)	77.6 (7.6)	78.4 (7.6)	<0.0001	77.8 (7.8)	77.9 (7.8)	0.2155
Ethnicity (%)						
White	24 330 (83.7)	3621 (79.4)	<0.0001	23 730 (83.2)	4207 (83.6)	0.9513
African American	1958 (6.7)	345 (7.8)		1952 (6.8)	3738 (6.7)	
Asian	1310 (4.5)	274 (6.0)		1343 (4.7)	232 (4.7)	
Hispanic	723 (2.5)	200 (4.4)		778 (2.7)	128 (2.7)	
Other	752 (2.6)	118 (2.6)		736 (2.6)	121 (2.4)	
Geographic area (%)						
Metro	24 529 (84.5)	3690 (81.1)	<0.0001	23 988 (84.1)	4256 (84.5)	0.6531
Urban	3986 (13.7)	763 (16.8)		4034 (14.1)	685 (13.6)	
Rural	509 (1.8)	10 (2.2)		518 (1.8)	97 (1.9)	
Charlson comorbidity index (%)						
0	15 920 (54.8)	2246 (49.3)	<0.0001	15 412 (54.0)	2699 (53.6)	0.3119
1-2	10 118 (34.8)	1761 (38.6)		10 078 (35.3)	1763 (35.0)	
≥3	3035 (10.4)	551 (12.1)		3049 (10.7)	574 (11.4)	
Gender (%)						
Male	13 389 (46.1)	950 (20.8)	<0.0001	12 166 (42.6)	2150 (42.7)	0.9372
Female	15 684 (53.9)	3608 (79.2)		16 374 (57.4)	2887 (57.3)	
Falls (%)						
Within 2 years of treatment	2975 (10.2)	439 (9.6)	0.2113	2980 (10.4)	472 (9.4)	0.0223

3.4 | OAB treatment and risk of falls

In Table 3, we present the association between OAB treatment and falls following the treatment for the OAB group. Model 1 shows the unadjusted risk of falls associated with OAB treatment. The odds of a fall were lower for those with OAB treatment, compared to those without OAB treatment (OR = 0.94, CI = 0.84, 1.04), though statistically not significant. In Model 2 (inverse propensity score weighted), the odds of a fall associated with OAB treatment were significantly lower compared to those without an OAB treatment (OR = 0.88, CI = 0.80, 0.98). Finally, the results of instrumental variable analysis are presented in Model 4. Compared to those without OAB treatment, the odds of a fall were lower for those with OAB treatment (OR = 0.98, CI = 0.97, 0.99), validating that OAB treatment had negative association with risk of falls. Additionally, to confirm the effects of OAB diagnosis as well as those of OAB treatment, we analyzed the full sample by creating dummy variables for OAB with treatment, OAB without treatment and no OAB diagnosis (reference category). Compared to the reference category of no OAB diagnosis, the odds of a post treatment fall were 1.54 (CI = 1.48, 1.61) for OAB without treatment group, and 1.31 (CI = 1.20, 1.44) for OAB with treatment group (data not shown).

4 | DISCUSSION

Overactive bladder syndrome is the most common cause of urinary incontinence in older adults.[6,19–24] Our study aimed at analyzing the association between this pervasive condition and the risk of falls among older adult Medicare fee-for-service enrollees. We observed that an OAB diagnosis was associated with higher risk of falls, compared to those without OAB. More importantly, our study is the first to show that within the OAB group, the risk of falls was lower for those who had received treatment for their OAB; compared to those OAB patients who were did not receive OAB treatment. Our estimates of association were statistically adjusted for demographic characteristics, history of prior falls, Charlson co-morbidity score, the propensity of receiving treatment, and finally, for instrumental variable to correct unmeasured bias. We believe our study results have important implications for clinical care, research, and policy related to OAB care.

TABLE 3 Association between overactive bladder (OAB) and falls; and treatment for overactive bladder (OAB) and falls

	Odds ratio	95% confidence intervals
Association between OAB diagnosis and Falls (full sample)[a]		
Model 1: Unadjusted		
	1.70	1.64-1.77
Model 2: Adjusting for clinical and demographic covariates		
	1.59	1.53-1.65
Association between treatment for OAB and Falls (sub-sample: OAB group only)[b]		
Model 1: Unadjusted		
	0.94	0.84-1.04
Model 2: Propensity score adjusted		
	0.88	0.80-0.98
Model 3: Instrumental variable adjusted		
	0.98	0.97-0.99

[a]Odds ratios represent the comparison of OAB patients versus those without OAB (reference category).

[b]Odds ratios represent the comparison of OAB patients with treatment versus OAB patients without treatment (reference category).

We present certain limitations of the study. Our sample consisted of men and women aged 66 years and older, and not enrolled in an HMO. Administrative data has become an important source of information for public health and health services research, but are subject to error. Studies employing medical records as a validation criterion for administrative data show generally good agreement for medical conditions and for procedures.[25] In our study, we did not account for intensity, duration, and adherence to OAB treatment. Additionally, we did not account for behavioral therapies for OAB in our analysis. The threshold for OAB diagnosis may vary from physician to physician, but studies of the use of claims data for OAB have shown generally good agreement.[12] Nevertheless, OAB may be a challenge to diagnose in older adults and physicians vary widely in recognition of and in inclination to code OAB. It is possible for patients with milder forms of OAB to be misclassified into non-OAB group, leading to conservative estimates of association between OAB diagnosis and falls. Finally, measures of cognition and functional capacity were not available, however, adjusting for comorbidity index, and prior falls may have accounted for it to certain extent.

Despite these limitations, our study draws attention to a largely silent problem of OAB and its association with falls among older adults. Important strengths of this study are as following. First, we have demonstrated the association between diagnosis of OAB and falls in a large sample of fee-for-service Medicare beneficiaries. Second, we demonstrated that treatment of OAB was associated with lower falls among Medicare beneficiaries. Third, potential measured and unmeasured bias were minimized using propensity score and instrumental variable approaches. Urinary incontinence has significant impact on the quality of life for many frail community-dwelling adults.[6,14,21,22] The majority of adults over 65-years-old experience some sort of incontinence.[20,21,26] Urinary incontinence is estimated to affect 13-53% of the homebound older adult population.[23] This condition in the older population is humiliating, disabling, stressful, depressing, and limiting.[3,5,11] As a result, only an estimated 1.4-2.9% of older adult people with OAB receive medical treatment for the condition.[5,9,21] The prevalence of Medicare beneficiaries over 65-years-old with an OAB diagnosis is estimated to range between 8.8% (for the base definition) to 13.6% (for the sensitivity definition).[12]

Falls are a major concern for the older adult population.[8,13,15,27,28] Approximately one-third of community-dwellers over the age of 65-years-old fall at least once annually.[10] Falls cause 90% of hip fractures and are the fifth leading cause of death among the older adult population. Legislation such as the Deficit Reduction Act of 2005 and the Fiscal Year 2009 Inpatient Prospective Payment System Final Rule, has even felt it necessary to attempt to provide financial incentives to hospitals to reduce falls.[13] The most cited risk factor for falling among the Medicare population is prior fall history.[9,22–24,27,28] Older patients with OAB reduce their gait speed and stride length, however, their gait variability is increased, reducing their walking stability overall and increasing their risk of falls.[8,10]

Existing research indicates association between urinary incontinence/OAB and an increased risk of falls among older adult. Research indicates that urinary incontinence and nocturia have been associated with falls in the older adult.[8,10–13,22–24,27–29] Overactive bladder has also been associated with falls in the older adults.[8,22] For example, a recent study of frail older adults found that 27% of falls occurred at night and 54% of those falls were related to visits to the bathroom.[23] Despite the existing literature, this relationship requires further comprehensive research.

5 | CONCLUSIONS

The widespread under diagnosis and under treatment for OAB has many implications for morbidity and quality of life of Medicare older adults. As rates of OAB symptoms appear to increase with advancing age, several factors may complicate diagnosis and treatment of OAB.[5,6,8–10] Although, OAB may not contribute as much to mortality among older patients as

cardiovascular disease or diabetes, OAB is associated with impaired functional status, health related quality of life and depression. We conclude that an OAB diagnosis is associated with higher risk of falls and treatment for OAB may be associated with reducing the risk of falls among Medicare fee-for service older adults. Complexity of falls etiology, particularly in frail older adults, requires detailed analysis to determine the contribution of several variables including cognitive function. We observed that even after adjusting for prior falls and comorbidity, treatment for OAB was associated with lower risk of falls. Thus, further research can focus on the development of a comprehensive theoretical model to determine the exact path of association between cognitive function, falls and OAB among older adults.

Preventive education, early diagnosis, and early treatment may help in lowering the risk of falls and thus improve the quality of life and morbidity among older adults with OAB. Although most of the older adult patients may not develop clinically significant OAB, additional research on identification of OAB and effective interventions is needed to alleviate the burden of OAB among Medicare beneficiaries, their families, and society.

ACKNOWLEDGMENT

This work was partially supported by Agency for Healthcare and Research Quality 1R01HS024106-01.

CONFLICTS OF INTEREST

None to disclose.

ORCID

Ravishankar Jayadevappa http://orcid.org/0000-0002-2638-0051
Sumedha Chhatre http://orcid.org/0000-0002-4718-0198
Diane K. Newman http://orcid.org/0000-0002-5083-6397

REFERENCES

1. Abrams P, Cardozo L, Fall M, et al. The standardization of terminology of lower urinary tract function: report from the standardization sub-committee of the International Continence Society. *Neurourol Urodyn*. 2002;21:167–178.
2. Tubaro A. Defining overactive bladder: epidemiology and burden of disease. *Urology*. 2004;64:2–6.
3. Irwin DE, Milson I, Hunskaar S, et al. Population-based survey of urinary incontinence, overactive bladder, and other lower urinary tract symptoms in five countries: results of the EPIC study. *Eur Urol*. 2006;50:1306–1315.
4. Milsom I, Coyne KS, Nicholson S, Kvasz M, Chen CI, Wein AJ. Global prevalence and economic burden of urgency urinary incontinence: a systematic review. *Eur Urol*. 2014;65:79–95.
5. Anger JT, Saigal CS, Madison R, Joyce G, Litwin MS. Increasing costs of urinary incontinence among female Medicare beneficiaries; Urologic Diseases of America Project. *J Urol*. 2006;176:247–251.
6. Berardelli M, De Rango F, Morelli M, et al. Urinary incontinence in the elderly and in the oldest old: correlation with frailty and mortality. *Rejuvenation Res*. 2013;16:206–211.
7. Thuroff JW, Abrams P, Andersson KE, et al. EAU guideline on urinary incontinence. *Eur Urol*. 2011;59:387–400.
8. Booth J, Paul L, Rafferty D, MacInnes C. The relationship between urinary bladder control and gait in women. *Neurourol Urodyn*. 2013;32:43–47.
9. Brito TA, Coqueiro Rda S, Fernandes MH, de Jesus CS. Determinants of falls in community-dwelling elderly: hierarchical analysis. *Public Health Nurs*. 2014;31:290–297.
10. Brown JS, Vittinghoff F, Wyman JF, et al. Urinary incontinence: does it increases risk for falls and fractures? Study of Osteoporotic Fractures Research Group. *J Am Geriatr Soc*. 2000;48:721–725.
11. Chiarelli PE, Mackenzie LA, Osmotherly PG. Urinary incontinence is associated with an increase in falls: a systematic review. *Aust J Physiother*. 2009;55:89–95.
12. Cisternas MG, Foreman AJ, Marshall TS, Runken MC, Kobashi KC, Seifeldin R. Estimating the prevalence and economic burden of overactive bladder among Medicare beneficiaries prior to Medicare Part D coverage. *Curr Med Res Opin*. 2009;25:911–919.
13. Clyburn TA, Heydemann JA. Fall prevention in the elderly: analysis and comprehensive review of methods used in the hospital and in the home. *J Am Acad Orthop Surg*. 2011;19:402–409.
14. Coyne KS, Sexton CC, Bell JA, et al. The prevalence of lower urinary tract symptoms (LUTS) and overactive bladder (OAB) by racial/ethnic group and age: results from OAB-POLL. *Neurourol Urodyn*. 2013;32:230–237.
15. Damián J, Pastor-Barriuso R, Valderrama-Gama E, de Pedro-Cuesta J. Factors associated with falls among older adults living in institutions. *BMC Geriatr*. 2013;13:1–6.
16. Anger JT, Goldman HB, Luo X, et al. Patterns of medical management of overactive bladder (OAB) and benign prostatic hyperplasia (BPH) in the United States. *Neurourol Urodyn*. 2018;37:213–222.
17. Ganz ML, Liu J, Zou KH, Bhagnani T, Luo X. Real-world characteristics of elderly patients with overactive bladder in the United States. *Curr Med Res Opin*. 2016;32:1997–2005.
18. Klabunde CN, Warren JL, Legler JM. Assessing comorbidity using claims data—an overview. *Med Care*. 2002;40:26-IV-35.
19. Ganz ML, Smalarz AM, Krupski TL, et al. Economic costs of overactive bladder in the United States. *Urology*. 2010;75:526–532.
20. Goode PS, Burgio KL, Richter HE, Markland AD. Incontinence in older women. *JAMA*. 2010;30:2172–2181.
21. Hawkins K, Pernarelli J, Ozminkowski RJ, et al. The prevalence of urinary incontinence and its burden on the quality of life among older adults with Medicare supplement insurance. *Qual Life Res*. 2011;20:723–732.
22. Khatutsky G, Walsh EG, Brown DW. Urinary incontinence, functional status, and health-related quality of life among medicare beneficiaries enrolled in the program for all-inclusive care for the elderly and dual eligible demonstration special needs plans. *Ambul Care Manage*. 2013;36:35–49.

23. Kraus SR, Bavendam T, Brake T, Griebling TL. Vulnerable elderly patients and overactive bladder syndrome. *Drugs Aging*. 2010;27:697–713.
24. Lee CY, Chen LK, Lo YK, et al. Urinary incontinence: an under-recognized risk factor for falls among elderly dementia patients. *Neurourol Urodyn*. 2011;30:1286–1290.
25. Hebert PL, Geiss LS, Tierney EF, Engelgau MM, Yawn BP, McBean AM. Identifying persons with diabetes using Medicare claims data. *Ame J Med Qual*. 1999;14:270–277.
26. Hasegawa J, Kuzuya M, Iguchi A. Urinary incontinence and behavioral symptoms are independent risk factors for recurrent and injurious falls, respectively, among residents in long-term care facilities. *Arch Gerontol Geriatr*. 2010;50:77–81.
27. Hunter KF, Wagg A, Kerridge T, Chick H, Chambers T. Falls risk reduction and treatment of overactive bladder symptoms with antimuscarinic agents: a scoping review. *Neurourol Urodyn*. 2011;30:490–494.
28. Kurita N, Yamazaki S, Fukumori N, et al. Overactive bladder symptom severity is associated with falls in community-dwelling adults: lOHAS study. *BMJ Open*. 2013;3:1–5.
29. Parsons JK, Mougey J, Lambert L, et al. Lower urinary tract symptoms increase the risk of falls in older men. *BJU Int*. 2009;104:63–68.

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

How to cite this article: Jayadevappa R, Chhatre S, Newman DK, Schwartz JS, Wein AJ. Association between overactive bladder treatment and falls among older adults. *Neurourology and Urodynamics*. 2018;1–7.
https://doi.org/10.1002/nau.23719