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Trends and Patterns of Urodynamic Studies in U.S. Women, 2000–2012

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Abstract

Objective—To estimate utilization rates for cystometrograms and describe trends in urodynamic procedures among U.S. women from 2000 to 2012.

Methods—We analyzed outpatient administrative healthcare claims for women aged 18 years or older from 2000–2012. The database contains de-identified and adjudicated claims from approximately 150 U.S. payers for employees, spouses, and retirees. We identified cystometrograms, which occur during bladder filling and represent a major component of complex urodynamics, and concurrent procedures; we also assessed age, year, region, provider specialty, and associated diagnosis codes. We estimated standardized cystometrogram utilization rates per 10,000 person-years and 95% confidence intervals (CI), and used stratified Poisson models to estimate the independent (adjusted) effects of year and region.

Results—During 142,928,847 person-years of observation among 57,629,961 eligible women, we identified 561,823 cystometrograms for an overall utilization rate of 39.3 per 10,000 person-years (95%CI 39.2–39.4). Cystometrogram utilization increased with age, with a peak at age 76 (86.6 per 10,000 person-years, 95%CI 84.5–88.7). Standardized rates were relatively constant from 2000 to 2004, then increased and peaked in 2009 (43.3 per 10,000 person-years, 95%CI 43.0–43.7). In 2012, they were substantially lower (27.6 per 10,000 person-years, 95%CI 27.4–27.9).

Conclusion—Urodynamic procedures were more commonly performed in women aged 65 years or older. Utilization peaked in 2009 and declined sharply in 2012. Clinically, we need to assess the

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underlying reasons for these trends (ie whether they reflect a decrease in urodynamics prior to stress incontinence surgery), and whether these trends reflect appropriate use of this diagnostic study.

INTRODUCTION

Urodynamic studies are commonly performed procedure in women for the evaluation of urinary incontinence and voiding dysfunction.(1–3) While urodynamic studies may assist in the evaluation of a patient with incontinence or voiding dysfunction, these costly procedures may be associated with an increased risk of UTI and discomfort.(4–6) Complex urodynamic investigations can include several components, such as uroflowmetry, cystometrograms, urethral pressure profile, and a voiding pressure study. Cystometrograms represent a major component of urodynamic procedures, as they are performed during bladder filling and can evaluate bladder sensation, bladder capacity, compliance, detrusor function, urodynamic stress incontinences and urethral function; thus, we considered this procedure to be broadly representative of urodynamics utilization.(1)

Currently, limited data exist regarding the trends and patterns of urodynamic procedures in the United States. It is important to evaluate this information given 1) recent studies in 2012(7) and 2013(8) have shown that preoperative urodynamic testing may not be needed for uncomplicated stress incontinence, 2) current procedural terminology (CPT) coding changes in 2010 decreased reimbursement which could potentially lead to a decline in utilization(9), and 3) the overall healthcare economic implications of these costly procedures. Given the need to evaluate trends in urodynamic procedures and the limitations in the existing literature, we sought to estimate the utilization rates for cystometrograms (i.e. the number of cystometrograms performed per 10,000 person-years experienced by the eligible population) and to describe trends in urodynamic procedures among U.S. adult women from 2000 to 2012.

MATERIALS AND METHODS

We conducted analyses using 13 years (2000–2012) of outpatient administrative health claims from the MarketScan database which includes de-identified and adjudicated healthcare claims from approximately 150 payers in the U.S. for employees, their spouses, dependents and retirees. Outpatient claims include encounters at outpatient doctor’s offices, ambulatory surgical centers, emergency rooms, and outpatient hospital facilities. The database includes the Commercial Claims & Encounters database, which is comprised of large employer-provided insurance plans for individuals under 65, and Medicare Supplemental database, which is comprised of employer-supplemented Medicare plans for individuals 65 or older.(10,11) Claims and enrollment data have been validated to ensure completeness, accuracy, and reliability.(12) In 2011, this database included approximately 53 million individuals. For context, 55.1% of the U.S. population in 2011, or 170.1 million individuals, had employment-based insurance; thus, this database includes a significant proportion of those with employer-based insurance.(13) Because few urodynamic procedures occur in the inpatient setting, inpatient medical claims were not included in the analysis.

The study population included all women aged 18 years or older. We identified index cystometrograms, which were considered the primary urodynamic procedure, based on Current Procedural Terminology (CPT) codes [51725, 51726, 51727, 51728, 51729]. We treated cystometrograms as the primary urodynamic procedure for two reasons: 1) we were interested in complex urodynamic investigations which nearly always include a cystometrogram(1) and 2) this was the approach taken by Reynolds et al. thereby allowing for comparison of our results.(14,15) We identified claims for additional urodynamic procedures performed on the same service date as the index cystometrogram, including uroflowmetry [51741], urethral pressure profiles [51772, 51727, 51729], voiding pressure studies [51795, 51797, 51728, 51729], electromyography [51784, 51785], and fluoroscopy/video-urodynamics [74430, 74450, 74455, 76000, 76001]. New CPT codes for urodynamic procedures were implemented in January 1, 2010 to allow for the bundling of payments for cystometrograms, voiding pressure studies, and urethral pressure profiles performed concomitantly (e.g. cystometrogram + voiding pressure study or cystometrogram + voiding pressure study + urethral pressure profile). To address this change in policy, bundled CPT codes were added to definitions of cystometrograms, voiding pressure studies, and urethral pressure profiles starting in 2010.

We evaluated patient age, calendar year, and region of service (i.e. Northeast, North Central, South, West, unknown). We also considered provider specialty and diagnoses associated with the index cystometrogram procedure (International Classification of Diseases, Ninth Revision, Clinical Modification [ICD-9-CM]). We assessed the diagnoses associated with cystometrograms by inspecting all ICD-9 diagnosis codes recorded with the urodynamic procedures. We collapsed the 30 most frequent diagnosis codes into 19 categories. For each cystometrogram, we determined provider type based on the specialty of the billing physician.

In order to estimate utilization rates for cystometrogram procedures, we divided the number of cystometrograms by the total enrolled person-time accrued by urodynamics-eligible women. We estimated cystometrogram utilization rates within strata of age, calendar year, and region of service, dividing the frequency of cystometrograms by the total person-time in each stratum.(16) While we considered cystometrograms to be representative of urodynamics use as a whole, we also estimated the proportion of cystometrograms accompanied by uroflowmetry, voiding pressure studies, urethral pressure profiles, electromyography, and fluoroscopy. We assumed procedures were concomitant to the index cystometrogram only if they were performed on the same date of service. In order to describe temporal changes in the type/complexity of urodynamic studies being used, we evaluated these proportions across different calendar years.

In order to observe trends in utilization by region and calendar year that were not confounded by changes in the age or regional representation of the study database over time, we estimated standardized utilization rates and 95% confidence intervals (CI). Calendar year utilization rates were standardized by age and region while regional utilization rates were standardized by age and calendar year. Standardized utilization rates were calculated by reweighting the data in each year/region such that the distribution of person-time in all years/regions resembled the same standard population.(17) This standard population was

defined using the 2010 Current Population Survey (CPS) and included U.S. women younger than 65 with employer-provided health plans and U.S. women 65 years and older with employer-supplemented Medicare plans, as estimated by the 2010 Current Population Survey (CPS).(18)

We used Poisson regression to estimate utilization rate ratios and 95% CI adjusted by age and calendar year for regional comparisons and adjusted by age and region for calendar year comparisons. We also stratified the models by age (<65 and ≥65) and used Wald chi-square statistics to evaluate whether each individual year 2005 to 2012 was significantly different from a referent period of 2000 to 2004.

This study was reviewed by University of North Carolina's institutional review board (study #: 10-0153) and found to be exempt. All analyses were conducted with SAS 9.3 (SAS Institute, Cary, NC).

RESULTS

Among 57,629,961 eligible women in the database contributing an average of 2.48 person-years each, we observed 142,928,847 total person-years of eligibility. We identified 561,823 cystometrograms (493,956 unique patients) for an overall utilization rate of 39.3 per 10,000 person-years (95% CI 39.2–39.4). The size of the study cohort increased substantially over time (as Truven Health Analytics expanded the number of employer-based health plans that it aggregated), accruing 1,583,535 person-years in 2000 and 19,597,100 person-years in 2012. Table 1 presents the total person-time and cystometrogram procedure frequencies observed in each category of age, calendar year, and region of service.

Cystometrogram utilization rates had a minor peak in the crude rate at age 50 (49.0 per 10,000 person-years, 95% CI 48.3–49.8) and a major peak at age 76 (86.6 per 10,000 person-years, 95% CI 84.5–88.7). The standardized cystometrogram utilization rate, which was relatively constant in the period 2000 to 2004, increased until 2009 and remained elevated in 2011 before decreasing in 2012 (Table 2). Figure 1 displays age-specific standardized cystometrogram utilization rates by calendar time. The rate peaked in 2009 (43.3 per 10,000 person-years, 95% CI 43.0–43.7), and was lowest after the sharp decline in 2012 (27.6 per 10,000 person-years, 95% CI 27.4–27.9). While the age-adjusted cystometrogram utilization rate was highest in the South (40.2 per 10,000 person-years, 95% CI 39.9–40.4), we observed similar rates in the North Central, and Northeast (Table 2). The West, however, had a lower rate (27.6 per 10,000 person-years, 95% CI 27.2–27.9) than the other regions. Figure 2 displays age-specific standardized cystometrogram utilization rates by region.

Compared to 2000–2004, the age-adjusted cystometrogram utilization rate was significantly higher in each year from 2005 through 2012 among patients 65 years and older. Among patients under age 65, the rate in 2012 was lower than in 2000–2004 (Table 2). Among all patients, utilization was similar in the South, North Central, and Northeast, but lower in the West. Decreased utilization in the West was more pronounced among patients under 65 (0.66, 95% CI 0.65–0.67) than among patients 65 and older (0.77, 95% CI 0.75–0.78).

Voiding pressure studies were performed concomitantly with 81.0% of cystometrograms, uroflowmetry with 73.0%, electromyography with 56.7%, urethral pressure profiles with 54.9%, and fluoroscopy with 5.2% (Table 3). Evaluating the change in these proportions over the study period yielded an absolute increase of at least 30% for voiding pressure studies, uroflowmetry, electromyography, and urethral pressure profiles (Figure 3). The proportion of cystometrograms accompanied by fluoroscopy procedures fell steadily over the study period from 7.6% in 2000 to 5.1% in 2012. The most frequent diagnoses accompanying cystometrograms were stress urinary incontinence (39.0%), frequency/urgency/nocturia (16.1%), mixed incontinence (13.5%), unspecified urinary incontinence (10.4%), and urge urinary incontinence (10.1%), which account for 39.0%, 16.1%, 13.5%, 10.4%, 10.1% of cystometrograms ordered, respectively (Table 3). Most cystometrograms performed on female patients were billed by either urologists (39.0%) or obstetrician–gynecologists (36.6%) (Table 3).

DISCUSSION

Our utilization rate estimates provide important insight into the patterns of urodynamic testing in U.S. women. Our study provides novel age-specific rates which show that the rates of urodynamic studies increased with age and that these procedures are commonly performed in women over 65 years of age (Table 2, Figure 1). Utilization rates increased from 2011 and then declined sharply in 2012. Additionally, over the last decade, these studies have become more complex, as cystometrograms were more commonly accompanied by uroflowmetry, urethral pressure profiles, voiding pressure studies and electromyography in 2012 compared to 2000 (Figure 3).

When trying to understand these trends, there are a number of different factors to consider. One influence may be the growing number of providers trained to perform complex urodynamic procedures in women. The decrease in the 2012 rate could reflect practice patterns for not conducting preoperative urodynamics before stress incontinence surgery, a practice which has been substantiated by recent trials.(7,8). CPT coding changes in 2010 decreased reimbursement, which may have influenced rates.(9) Another factor may be that fewer midurethral mesh slings were performed after the FDA safety notifications,(19) which reduced the need for preoperative urodynamic procedures. The clinical implications of our results are that we need to continue to assess the indications for urodynamic testing, the underlying reasons for changes in trends over time, and whether these trends reflect appropriate use, or over- or under-utilization of this diagnostic study.

Prior studies on trends in urodynamics did not provide data from 2010–2012, which is important to assess given changes in CPT codes for these procedures.(14,15,20) A prior analysis conducted on a combined male and female cohort evaluated commercial healthcare claims for urodynamics from 2002–2007, but did not estimate utilization rates or trends over calendar time.(15)

Reynolds et al.(14) validly assessed utilization from 2000–2009; however, they failed to capture codes for cystometrograms bundled with voiding pressure studies or urethral pressure profiles that were introduced in 2010. Furthermore, they did not control for

differences in age distributions when comparing utilization by calendar year, region, race, and urban/rural status, which may explain differences between our results. We felt that standardization was necessary, given the potential for differences in age profiles over the 13 calendar years being compared and in the different regions to confound the interpretation of trends.

While our study found similar patterns-of-use in older patients groups to the Reynolds et al. (14) study on Medicare beneficiaries (i.e. peak rates among women 75–79, decrease in those 80–84, sharp decline in women >84), our cystometrogram rates were substantially higher, which may be driven by a number of factors. First, Reynolds et al. calculated a one-year incidence proportion (per person), while we calculated an incidence rate (per person-year). Second, our study population ≥65 (i.e. women with employer-supplemented Medicare coverage) may actually utilize more urodynamic procedures than the general Medicare fee-for-service population evaluated by Reynolds.

This study has a number of limitations. First, given that our healthcare claims data did not include specific patient-level information regarding indications for the procedures or the results, we are unable to comment on the appropriateness of increasing or decreasing rates. Second, comparisons and trends may be confounded by unmeasured variables not routinely available in claims data (e.g. race/ethnicity, BMI). Third, this study population represents women with employer based insurance and thus our results may not be generalizable to Medicaid enrollees, underinsured individuals, or the uninsured. Lastly, while expect false or missing claims to be rare for urodynamic procedures, actual utilization rates may be slightly higher or lower than those estimated.

The strengths of our study include that we used a large population-based cohort which includes recent years of data that have not been captured in the existing literature, with claims for both older (≥65) and younger (<65) patients. The sample of cystometrograms studied is eight times larger than the next largest study(14), which allowed for the calculation of precise utilization rate estimates and detailed analysis age-specific trends by calendar year. We also focused exclusively on women, providing unique insights into trends in women which may be quite different from those in men. Finally, we used Poisson models and standardization methods to enable the evaluation of independent effects of calendar year and region.

In conclusion, urodynamic investigations were most common in women older than 65 and increased in use and complexity over the last decade. These trends have important healthcare cost implications given the increasing expenditures from these urodynamic studies. Future research will be needed to assess the appropriateness of urodynamic testing and if the declining utilization of urodynamic procedures continues in subsequent years.

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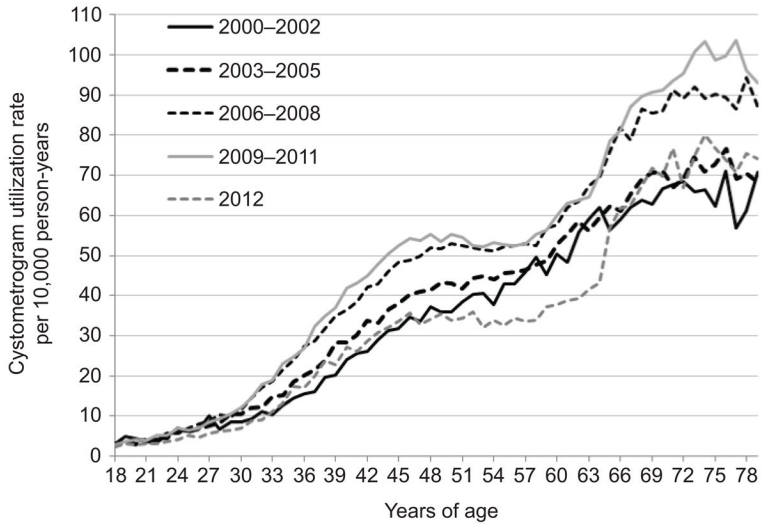

Figure 1.

Age-specific cystometrogram utilization rates per 10,000 person-years by calendar year, U.S. women 2000–2012. Age-specific rates within each calendar year time period have been standardized by region using the regional distribution observed in the 2010 Current Population Survey.

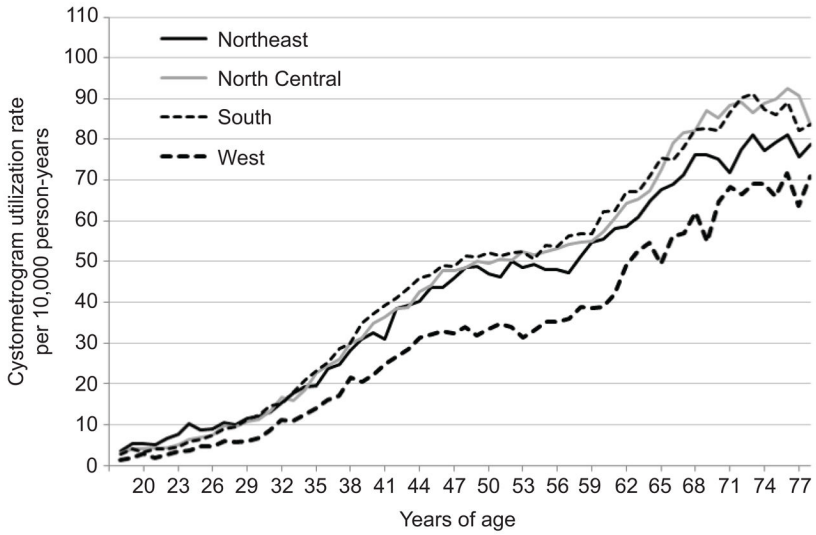

Figure 2.

Age-specific cystometrogram utilization rates per 10,000 person-years by region, U.S. women 2000–2012. Age-specific rates within each region have been standardized by calendar year, assuming equal representation from each year of data (2000–2012).

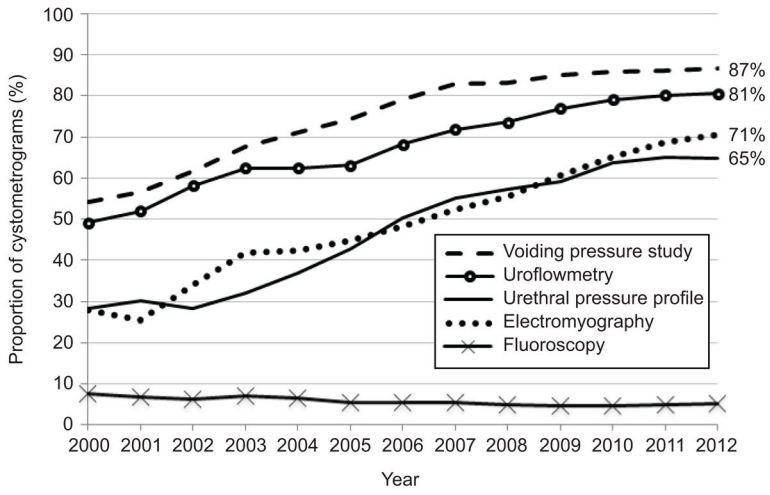

Figure 3.

Proportion of cystometrograms accompanied by voiding pressure studies, urethral pressure profiles, electromyography, and fluoroscopy procedures by calendar year, U.S. women 2000–2012.

Table 1

Observed person-time and cystometrogram procedure frequencies by age, calendar year, and region of service, for U.S. women, 2000–2012.

	Person-years	n
Age		
18–24	15,665,026	6,181
25–29	10,385,911	8,362
30–34	11,947,530	18,325
35–39	13,189,724	36,449
40–44	14,645,040	57,690
45–49	15,983,160	75,879
50–54	16,188,969	78,706
55–59	14,842,490	74,857
60–64	11,875,626	70,756
65–69	4,963,459	37,599
70–74	4,141,817	34,709
75–79	3,614,829	30,406
80–84	2,867,981	20,382
85+	2,617,286	11,522
Year		
2000	1,583,535	5,569
2001	2,608,311	9,316
2002	4,483,152	15,411
2003	6,901,888	22,079
2004	8,989,072	31,387
2005	9,899,448	38,653
2006	10,553,919	43,514
2007	10,607,102	45,347
2008	15,583,619	68,068
2009	15,551,472	71,346
2010	16,946,406	74,397
2011	19,623,824	81,897
2012	19,597,100	54,839
Region		
South	58,041,737	238,135
North Central	36,357,369	154,459
West	27,448,395	80,135
Northeast	19,442,855	82,214
Unknown	1,638,491	6,880

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Table 2

Standardized utilization rates and age-adjusted utilization rate ratios by calendar year and region, for U.S. women 2000–2012.

	Rate[1]		Rate Ratios[2]					
	per 10,000 person-years		< 65 years old			≥ 65 years old		
	Rate	95% CI	Rate Ratio	95% CI	p	Rate Ratio	95% CI	p
Calendar Year								
2000	31.1	(30.1–32.1)						
2001	30.5	(29.8–31.2)						
2002	30.4	(29.9–30.9)	1.00	-	-	1.00	-	-
2003	30.3	(29.9–30.8)						
2004	32.8	(32.4–33.2)						
2005	37.0	(36.6–37.4)	1.18	(1.15–1.21)	<.001	1.12	(1.11–1.18)	<.001
2006	39.1	(38.7–39.5)	1.25	(1.22–1.28)	<.001	1.32	(1.24–1.32)	<.001
2007	40.3	(39.9–40.7)	1.28	(1.25–1.31)	<.001	1.39	(1.31–1.39)	<.001
2008	41.4	(41.0–41.7)	1.30	(1.27–1.33)	<.001	1.36	(1.30–1.37)	<.001
2009	43.3	(43.0–43.7)	1.35	(1.32–1.37)	<.001	1.47	(1.41–1.48)	<.001
2010	42.6	(42.3–42.9)	1.33	(1.30–1.36)	<.001	1.47	(1.42–1.49)	<.001
2011	40.6	(40.3–40.9)	1.26	(1.24–1.29)	<.001	1.36	(1.30–1.36)	<.001
2012	27.6	(27.4–27.9)	0.84	(0.82–0.86)	<.001	1.08	(1.04–1.10)	<.001
Region								
South	40.2	(39.9–40.4)	1.00	-		1.00	-	
North Central	39.1	(38.9–39.4)	0.94	(0.93–0.95)	<.001	1.01	(0.99–1.03)	.328
West	27.6	(27.2–27.9)	0.66	(0.65–0.67)	<.001	0.77	(0.75–0.78)	<.001
Northeast	37.1	(36.7–37.5)	0.99	(0.98–1.01)	.303	0.95	(0.93–0.97)	<.001
Unknown	-	-	1.06	(1.00–1.11)	.035	0.96	(0.91–1.02)	.187

[1] Standardized utilization rate estimates by calendar year are standardized by age and region while estimates by region are standardized by age and calendar year. We reweighted estimates to resemble a standard population of U.S. women with employer-provided health plans (below age 65) and U.S. women with employer-supplemented Medicare plans (over age 65), as estimated by the 2010 Current Population Survey.

[2] We estimated utilization rate ratios by calendar year using age and region adjusted Poisson regression models, and by region using age and calendar year adjusted Poisson regression models. We used a referent of 2000–2004 for the calendar year rate ratios and the South for the regional rate ratios.

Table 3

Counts by procedure type, associated diagnosis, and provider specialty and the proportion of cystometrograms represented by each, for U.S. women, 2000–2012.

	n	CMGs (%)
Procedures Accompanying cystometrograms[1,2]		
Cystometrogram	561,823	100
+ Voiding pressure study	454,919	81.0
+ Uroflowmetry	409,997	73.0
+ Electromyography	318,301	56.7
+ Urethral pressure profile	308,349	54.9
+ Fluoroscopy	29,214	5.2
Diagnosis[2,3,4]		
Stress urinary incontinence	219,153	39.0
Frequency/urgency/nocturia	90,208	16.1
Mixed incontinence	76,019	13.5
Unspecified urinary incontinence	58,408	10.4
Urge urinary incontinence	56,805	10.1
Incomplete emptying/obstruction/retention	43,702	7.8
Cystocele	29,694	5.3
Urinary tract infection/cystitis	19,018	3.4
Hypertonicity of bladder	15,927	2.8
Other functional disorder of bladder	15,364	2.7
Neurogenic bladder	12,727	2.3
Provider Specialty[5]		
Urology	213,398	38.0
Obstetrics & gynecology	205,575	36.6
Medical doctor	60,863	10.8
Multi-specialty physician group	18,098	3.2
Other	17,512	3.1
Missing	46,377	8.3

[1] "CMGs (%)" refers to the proportion of cystometrogram service encounters that were accompanied by each procedure (on the same day). For example, 81.0% of cystometrograms were performed concomitantly with voiding pressure studies.

[2] Since a single cystometrogram can be accompanied by multiple procedures or multiple diagnosis codes, summing the "CMGs (%)" column across these variables yields a value greater than 100%

[3] Diagnosis counts are based on any diagnosis associated with any of the procedures ordered on a single service day for a given enrollee, not just the cystometrogram. Diagnoses that were coded for multiple procedures on the same day were not double counted. "CMGs (%)" refers to the proportion of cystometrogram service encounters that contained each diagnosis code. For example, 39.0% of cystometrograms ordered for women were associated with a code for stress urinary incontinence.

[4] We used ICD-9 diagnosis codes to define the diagnosis categories as follows: stress urinary incontinence (625.6), frequency/urgency/nocturia (788.41, 788.43, 788.63), mixed incontinence (788.33), unspecified urinary incontinence (788.3), urge urinary incontinence (788.31), incomplete emptying/slow stream/retention (788.20, 788.21, 788.62), cystocele (618.0, 618.01, 618.02), urinary tract infection/cystitis (599.0, 595.1, 595.2), hypertonicity of bladder (596.51), other functional disorder of bladder (596.59), neurogenic bladder (596.54).

[5]Provider specialty counts reflect the provider that billed the index cystometrograms, not necessarily providers that billed other urodynamic exams. “CMGs (%)” refers to the proportion of cystometrograms billed by each specialty.