Published in final edited form as:
J Urol. 2013 May ; 189(5): 1791–1796. doi:10.1016/j.juro.2012.11.066.

Patterns and Predictors of Urodynamics Use in the United States

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Abstract

Purpose—Due to the paucity of data on urodynamics on the national level, we assessed the use of urodynamics in a large sample of individuals in the United States and identified predictors of increased complexity of urodynamic procedures.

Materials and Methods—Using administrative health care claims for adults enrolled in private insurance plans in the United States from 2002 to 2007, we identified those who underwent cystometrogram and abstracted relevant demographic and clinical data. We used logistic regression to identify predictors of higher urodynamic complexity over basic cystometrogram, specifically cystometrogram plus pressure flow study and videourodynamics.

Results—We identified 16,574 urodynamic studies, of which 23% were cystometrograms, 71% were cystometrograms plus pressure flow studies and 6% were videourodynamics. Stress incontinence was the most common clinical condition for all studies (33.7%), cystometrogram (30.8%), cystometrogram plus pressure flow study (35.4%) and videourodynamics (24.4%). Urologists performed 59.8% of all urodynamics and gynecologists performed 35.5%. Providers with 14 or more urodynamic studies during the study period performed 75% of all urodynamics and were more likely to perform cystometrogram plus pressure flow study and videourodynamics. On regression analysis the most consistent predictors of cystometrogram plus pressure flow study and/or videourodynamics over cystometrogram were specialty (urologist) and the number of urodynamic tests performed by the provider.

Conclusions—Most urodynamics in this series consisted of cystometrogram plus pressure flow study with stress incontinence the most common diagnosis. However, regardless of diagnosis, urologists and providers who performed more urodynamics were more likely to perform pressure flow study and/or videourodynamics in addition to cystometrogram. Further research is needed to determine whether these differences reflect gaps in the consistency or appropriateness of using urodynamics.

Keywords

urinary bladder; neurogenic; urinary incontinence; urodynamics; physician’s practice patterns; diagnosis

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†Financial interest and/or other relationship with Allergan, Johnson & Johnson and Merck.

Urodynamics are a series of investigations and procedures performed on the LUT to identify the cause of symptoms and quantify related pathophysiological processes.[1,2] They are an important tool to evaluate, diagnose and treat individuals complaining of voiding disorders since they are the only objective way to determine why individuals have LUTS.[3]

The clinical applications of UDS can be broad. Consensus is lacking on which patients and for which voiding symptoms UDS should be routinely performed. While several professional organizations have published practice guidelines and recommendations,[1,3–8] they tend to focus primarily on UI and controversy still exists over the appropriate applicability.[9]

Due to a paucity of existing data on UDS on the population level, we assessed UDS use in a large sample of individuals in the United States. We also determined commonly used UDS components, diagnoses that are common indications for UDS and predictive factors indicating a higher complexity of UDS testing.

MATERIALS AND METHODS

Data Source

We used administrative health care claims for individuals enrolled in private insurance programs available from 2002 to 2007 (I3 Innovus, Medford, Massachusetts).[10] This data set contains information on the health care utilization and demographics of approximately 30 million individuals in the United States. The study met our institutional review board exclusion criteria for research in human subjects.

Patient Population

We identified patients who underwent UDS according to CPT codes for CMG (51725 and 51726) on claims. We assessed demographic information from health care claims, including gender, age, race/ethnicity and region of residence as well as service dates and provider type (urologist, obstetrician/gynecologist and other). We excluded patients younger than 18 years from analysis and limited our sample to those with UDS in 2003 to 2006 so that we could search records 12 months before and after UDS.

UDS Procedures

Based on additional CPT codes on CMG claims, we tabulated the number of UDS procedures performed in the same setting as CMG. We then categorized UDS into 3 distinct groups, including 1) CMG—filling CMG only, 2) CMG plus PFS—filling CMG and PFS, and 3) VUDS—the addition of fluoroscopy, ie VUDS (table 1). Additional UDS components, such as UPP, leak point pressure, uninstrumented uroflowmetry and EMG, were reported for each UDS group but were not part of the group definitions.

Clinical Conditions and Diagnoses

We used all ICD-9 codes present on claims to classify the medical conditions and clinical diagnoses associated with UDS testing into exclusive categories. We classified claims with multiple diagnoses into the most relevant category based on combinations of diagnoses. Health care records from 12 months before and after UDS were also searched for claims documenting relevant LUT and pelvic surgical procedures. We defined complicated case as any UDS associated with prior surgery and not included in the SUI, nonNGB MUI or nonNGB UUI/OAB diagnostic categories based on International Consultation on Incontinence recommendations.[11]

Statistical Analysis

We developed multivariate logistic regression models to evaluate associations of higher UDS complexity (CMG vs CMG plus PFS and/or VUDS) with clinical and demographic factors that may predict UDS, including age, gender, race (white vs nonwhite), region, previous surgery, provider specialty type and provider volume (fewer than 14, 14 to 90 or greater than 90 UDS cases). We separated analyses by diagnostic classifications and only included generally accepted indications for UDS,[8,11] including NGB, POP, voiding dysfunction (ie urinary retention, obstruction or incomplete emptying, including benign prostatic hyperplasia), SUI, nonneurogenic OAB and UUI (including MUI). Results are reported as the OR and 95% CI with CIs not including 1.00 considered significant. All statistical analysis was done with SAS®.

RESULTS

We identified 16,574 UDS procedures, of which 23% were CMG, 71% were CMG plus PFS and 6% were VUDS (table 1). Uninstrumented uroflowmetry was done in 68% of UDS cases, including 35% of CMG, 65% of PFS and 83% of VUDS studies. EMG similarly increased from 18% of CMGs to 82% of VUDS. UPP and/or leak point pressure testing was done in 41% of all studies, most commonly in CMG plus PFS (48%). Only 23% and 24% of CMGs and VUDS, respectively, included UPP/leak point pressure testing.

UDS were more commonly performed in women (83%) (table 2). However, proportionally more men than women underwent CMG (26% vs 22%) or VUDS (10% vs 6%, each $p < 0.001$), while women were more likely to undergo CMG plus PFS (72% vs 64%, $p < 0.001$). UDS were also more commonly done in white than in nonwhite patients (70% vs 30%). Regionally, most UDS were performed in the South (47%), where more CMGs plus PFS (48.4%) and VUDS (65.3%) were also done than in other regions.

Urologists performed most UDS overall (59.8%), including 53.0% of CMG, 58.6% of CMG plus PFS and 87.7% of VUDS studies. The median number of UDS was 59 (IQR 25, 112) per urologist, 18 (IQR 6, 53) per gynecologist and 23 (IQR 6, 85) per other provider type. Providers who performed at least 14 UDS studies performed 75% of all UDS. Proportionally, CMG represented a greater percentage of cases done by low volume providers (fewer than 14) than by medium and high volume providers (29.6% vs 21.4% and 17%, respectively). Similarly, high volume providers performed more VUDS proportionally than medium and low volume providers (9.8% vs 6.1% and 2.8%, respectively). As case volume increased, the proportion of CMG plus PFS also increased from 67.6% of low to 72.6% of medium and 73.2% of high volume provider cases.

Overall, SUI alone was the most common diagnosis of all UDS (33.7%) and for all levels of UDS complexity, including 30.8% of CMG, 35.4% of CMG plus PFS and 24.4% of VUDS studies (table 3). Of UDS tests 10,674 (64%) were associated with a bladder storage condition diagnosis, ie nonneurogenic UI and/or OAB. Of these studies 20% were CMG, 75% were CMG plus PFS and 5% were VUDS. Of UDS associated with voiding dysfunction, ie urinary retention, obstruction or incomplete emptying, 530 (26%) did not include PFS components specifically, while 156 (7.5%) included VUDS. Similarly, for NGB conditions 347 studies (30%) did not include PFS, while 112 (9.5%) included VUDS. A history of surgery within the preceding 12 months was more common as complexity increased, ranging from 1.9% of CMG to 4.2% of VUDS. Overall, 2.1% of UDS were performed in patients with a history of surgery. Also, 42.9% of UDS were done for complicated cases, representing 50.7% of CMG, 39.5% of CMG plus PFS and 51.8% of VUDS studies.

When the probability of undergoing CMG plus PFS or VUDS over CMG was adjusted for on multivariate regression, the most consistent predictors of higher complexity across diagnostic categories were provider specialty and UDS case volume (table 4). While they differed statistically, gynecologists and other providers were always less likely to perform CMG plus PFS or VUDS than urologists. For all diagnoses except voiding dysfunction providers who performed 14 to 90 or greater than 90 UDS studies were consistently more likely to perform CMG plus PFS or VUDS over low volume (less than 14) providers.

DISCUSSION

In this study of a large number of UDS tests from a sample of American patients the combination of filling CMG and PFS represented the majority of UDS. These studies also included uroflowmetry, UPP/leak point pressure and EMG in most cases. In contrast, VUDS was performed infrequently. UI in general and SUI specifically were coded at the time of most UDS cases. However, a number of studies were associated with conditions such as LUT fistula and diverticula, recurrent urinary tract infections, hematuria, interstitial cystitis and pain, and other nonspecific diagnoses. Overall, 43% of studies represented complicated cases of LUT function or UI. After controlling for multiple variables, the most consistent predictors across diagnoses were case volume, ie the number of UDS performed by the practitioner, and provider specialty.

It is unclear how many urologists or gynecologists perform UDS regularly in practice. According to American Board of Urology data on case logs for certifying and recertifying urologists in 2010, the median number of UDS studies was 22 for certifying urologists and 58 for recertifying urologists.[12] In contrast, a reputed expert in voiding dysfunction applying for recertification performed 1,030 UDS tests. In our study, in which providers must have performed at least 1 UDS study, those with more than 14 during 3 years performed 75% of all such studies, including a median of 59 by urologists and 18 by gynecologists.

Our data suggest that higher volume providers perform more UDS, including more UDS with more components, such as PFS and VUDS. What drives this is uncertain. Various factors may contribute, such as unmeasured confounding, case mix, referral patterns for expertise and concentration of care at high volume centers. It also may be driven by financial incentives since UDS is a well reimbursed procedure. Differences among provider specialties may reflect differences in patient populations and differences in philosophy in how or when UDS is done. Finally, the lack of better consistency across related specialties may also reflect relatively poor regulation and specificity in UDS use.

Recent American Urological Association guidelines on UDS identified 2 clear categories of patients who may benefit from UDS, including 1) those in whom information beyond that obtained by history, physical examination and basic tests is necessary to make an accurate diagnosis and direct therapeutic decisions, and 2) those in whom the LUT condition may have the potential to cause deleterious, irreversible effects on the upper urinary tract.[8] The guidelines also echo recommendations from the Fourth International Consultation on Incontinence[3,8] that UDS be performed 1) when results may change management, such as before most invasive treatments for UI and POP, 2) after treatment failure if more information is needed to plan further therapy, 3) as part of initial and long-term surveillance programs for some types of neurogenic LUT dysfunctions and 4) in cases of complicated incontinence, defined as recurrent UI or UI associated with pain, hematuria, recurrent infection, significant voiding symptoms, pelvic irradiation, radical pelvic surgery or suspected fistula.[11]

While these consensus statements are well accepted, controversy remains as to the specific applicability of UDS and its specific components for given conditions, for example whether UDS should be done before surgery in a woman with uncomplicated SUI. Recommendations from professional societies and health care organizations are mixed,[3–5,7,8] as are data showing clear benefits of preoperative UDS for predicting outcomes.[9,13–15] Recently, investigators from the VALUE (Value of Urodynamic Evaluation) clinical trial reported that 12-month outcomes after incontinence surgery were equivalent whether patients did or did not undergo UDS preoperatively,[16] suggesting that routine UDS are not necessary. Additional clinical trials addressing this are under way.[17] In our study the most common diagnosis at UDS was SUI, although we did not specifically determine how many women with SUI in the population underwent UDS preoperatively.

In one of the few population based studies of UDS Anger et al reported that UDS were done within 6 months preoperatively in 27.4% of women treated with an anti-incontinence sling procedure and within 12 months postoperatively in 30.5%, according to analysis of Medicare claims from 1999 to 2001.[18] Those with UDS preoperatively were less likely to undergo postoperative UDS (OR 0.34, 95% CI 0.24–0.48) or cystoscopy (OR 0.7, 95% CI 0.50–0.99) and more likely to be diagnosed with UUI (OR 2.07, 95% CI 1.43–2.99). In a separate analysis the investigators noted differences in UDS use based on specialty.[19] Gynecologists were more likely to perform UDS before sling surgery than urologists (41% vs 30%, $p < 0.002$). However, women treated by a urologist were less likely to undergo postoperative UDS than women treated by a gynecologist (OR 0.72, 95% CI 0.53–0.99).

For other LUT conditions and symptoms the role of UDS is perhaps less debatable, although also less studied. PFS is an integral component for assessing voiding abnormalities. It is generally recommended for NGB and LUTS associated with neurological conditions as well as for evaluating bladder outlet obstruction and voiding dysfunction after bladder outlet procedures.[5,8,20] In our series most UDS included PFS as a component, although many did not, including 28% associated with NGB and 26% associated with retention or obstruction.

The role of fluoroscopy during UDS, ie VUDS, has also not been fully elucidated. It is considered an important component for evaluating NGB or suspected LUT anatomical anomalies[8] and it may be useful in patients with urinary obstruction to localize the level of obstruction.[8,20] VUDS was also recommended as a component of the initial assessment of LUT function in patients with spinal cord injury, ie NGB, and as part of surveillance regimens in these patients to be performed when there are changes in symptoms, signs or management objectives, and in the setting of unsafe bladder features.[21] In this study VUDS were infrequently performed, while the most common associated diagnoses were SUI, and nonneurogenic UUI and OAB. Only 15% of VUDS were performed for retention/obstruction and 11% were done for NGB.

While we did not intend to specifically compare UDS use to adherence to recommended practice guidelines, the results provide some framework for comparison, as discussed. However, most referenced recommendations and guidelines were published after many of the procedures captured in this analysis were performed. Thus, we assume that most providers were not trying to adhere to prescribed guidelines. We also specifically did not analyze temporal trends in UDS components or indications. Thus, we cannot account for changes in indications with time. In addition, this patient population was not randomly selected, nor is it generalizable to the overall American population. In particular, the socioeconomic and demographic factors of these patients likely do not represent much of the general American population since they were patients and family members participating in employer sponsored insurance programs. Because our results were derived from diagnostic and procedural coding on administrative health care claims, they are subject to many sources of error, including errant coding and information bias (misclassification). This is a known limitation of this type of analysis and must be considered when interpreting our analysis.

CONCLUSIONS

UDS represent a heterogeneous group of test components that is not consistently used by providers for various LUT conditions. For most UDS procedures identified in this population, filling cystometry and PFS were done concurrently to diagnose or investigate SUI. VUDS were performed relatively infrequently and yet the most common diagnosis associated with these studies was still SUI. Increasing case volume, ie the number of UDS procedures performed by a provider, and provider specialty were the most consistent predictors of the increased complexity of UDS across diagnoses.

Abbreviations and Acronyms

CMG	cystometrogram
EMG	electromyography
LUT	lower urinary tract
LUTS	LUT symptoms
MUI	mixed UI
NGB	neurogenic bladder
OAB	overactive bladder
PFS	pressure flow study
POP	pelvic organ prolapse
SUI	stress urinary incontinence
UDS	urodynamics
UI	urinary incontinence
UPP	urethral pressure profilometry
UUI	urge urinary incontinence
VUDS	videourodynamics

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Table 1

UDS components and CPT codes commonly used for CMG for all UDS and across UDS complexity categories

UDS Testing Components (CPT codes*)	No. UDS (%)	No. CMG (%)	No. CMG + PFS (%)	No. VUDS (%)
CMG (51725, 51726)	16,574 (100)	3,818 (100)	11,721 (100)	1,035 (100)
Voiding pressure + bladder voiding pressure, any technique (51795, 51797)	12,756 (77.0)	0	11,721 (100)	1,035 (100)
Uroflowmetry (51736, 51741)	11,367 (68.6)	1,324 (34.7)	9,181 (78.3)	862 (83.3)
EMG (51784, 51785)	8,204 (49.5)	680 (18)	6,676 (57)	848 (82)
UPP or Valsalva leak point pressure, any technique (51772)	6,746 (40.7)	872 (23)	5,622 (48)	252 (24)
Fluoroscopy (51600, 74430, 74455, 74450, 76000, 76001)	1,035 (6.2)	0	0	1,035 (100)

*Coding revisions implemented in 2010 not shown.

Table 2

Study cohort demographics and provider information by UDS complexity

	All UDS	CMG	CMG + PFS	VUDS	p Value
Mean age ± SD	53.0 ± 13.1	53.5 ± 13.7	52.8 ± 12.9	53.5 ± 13.8	0.6
No. women (%)	13,803 (83.3)	3,101 (81.2)	9,949 (84.9)	753 (72.8)	<0.001
No. men (%)	2,770 (16.7)	717 (18.8)	1,771 (15.1)	282 (27.3)	
No. race (%):					
White	11,278 (68.1)	2,666 (69.8)	7,900 (67.4)	712 (68.8)	0.018
Nonwhite	5,296 (32.0)	1,152 (30.2)	3,821 (32.6)	323 (31.2)	
No. region (%):					
Midwest	4,988 (30.1)	1,459 (38.2)	3,394 (29.0)	135 (13.0)	<0.001
Northeast	1,996 (12.0)	494 (12.9)	1,349 (11.5)	153 (14.8)	
South	7,782 (47.0)	1,433 (37.5)	5,673 (48.4)	676 (65.3)	
West	1,807 (10.9)	432 (11.3)	1,304 (11.1)	71 (6.9)	
No. UDS by specialty (%):					
Urology	9,908 (59.8)	1,668 (52.9)	5,900 (58.6)	763 (87.7)	<0.001
Gynecology	5,853 (35.3)	1,291 (40.9)	3,771 (37.4)	37 (4.3)	
Other	813 (4.9)	195 (6.2)	404 (4.0)	70 (8.1)	
No. UDS/provider (%):					
Less than 14	3,565 (25.3)	1,056 (33.5)	2,408 (23.9)	101 (11.6)	<0.001
14–90	6,979 (49.5)	1,492 (47.3)	5,065 (50.3)	422 (48.5)	
Greater than 90	3,555 (25.2)	606 (19.2)	2,602 (25.8)	347 (39.9)	

Table 3

LUT diagnoses and conditions associated with UDS by complexity

Diagnosis	No. UDS (%)	CMG (%)	CMG + PFS (%)	VUDS (%)
Overall	16,574	3,818	11,721	1,035
SUI	5,579 (33.7)	1,174 (30.8)	4,152 (35.4)	253 (24.4)
UUI + OAB (nonneurogenic)	2,705 (16.3)	524 (13.7)	2,007 (17.1)	174 (16.8)
Urinary retention, obstruction or incomplete emptying, including benign prostatic hyperplasia	2,055 (12.4)	530 (13.9)	1,369 (11.7)	156 (15.1)
POP	1,421 (8.6)	399 (10.5)	919 (7.8)	103 (10.0)
Other UI	1,204 (7.3)	258 (6.8)	865 (7.4)	81 (7.8)
MUI (nonneurogenic)	1,186 (7.2)	185 (4.9)	929 (7.9)	72 (7.0)
NGB + associated neurological conditions	1,168 (7.1)	347 (9.1)	709 (6.1)	112 (10.8)
Other LUTS + bladder conditions, including hematuria + urinary tract infection	633 (3.8)	185 (4.9)	396 (3.4)	52 (5.0)
Interstitial cystitis + pelvic pain	420 (2.5)	121 (3.2)	281 (2.4)	18 (1.7)
LUT fistula or diverticulum	203 (1.2)	95 (2.5)	94 (0.8)	14 (1.4)
LUT surgery in prior 12 mos	349 (2.1)	74 (1.9)	232 (2.0)	43 (4.2)
Complicated*	7,104 (42.9)	1,935 (50.7)	4,633 (39.5)	536 (51.8)

*Any UDS associated with prior surgery and not included in SUI, nonNGB MUI and nonNGB UUI/OAB diagnostic categories.[11]

Table 4

Multivariate logistic regression of probability of higher complexity UDS, including CMG plus PFS and/or VUDS vs CMG, by diagnosis in 14,099 patients

	SUI OR (95% CI)	NonNGB UUI, OAB + MUI OR (95% CI)	Voiding Dysfunction OR (95% CI)	POP OR (95% CI)	NGB OR (95% CI)
No. pts*	5,572	3,887	2,054	1,418	1,168
Age	1.007 (1.001–1.013)†	0.999 (0.993–1.005)	0.989 (0.982–0.997)†	1.011 (1.001–.022)†	0.989 (0.981–0.998)†
Gender (F vs M)	0.945 (0.512–1.744)	0.933 (0.733–1.188)	1.443 (1.125–1.851)†	—	1.176 (0.895–1.546)
Race (white vs nonwhite)	0.862 (0.747–0.995)†	1.042 (0.873–1.244)	0.954 (0.764–1.193)	0.810 (0.620–1.058)	1.038 (0.786–1.372)
Region (vs West):					
Midwest	0.929 (0.748–1.155)	0.981 (0.745–1.292)	0.454 (0.314–0.656)†	0.652 (0.434–0.982)†	0.381 (0.237–0.614)†
Northeast	1.315 (0.992–1.744)	1.485 (1.072–2.059)†	0.411 (0.279–0.606)†	0.812 (0.476–1.382)	0.704 (0.416–1.192)
South	1.563 (1.265–1.932)†	1.713 (1.307–2.245)†	0.887 (0.619–1.272)	1.014 (0.681–1.510)	0.797 (0.495–1.282)
Previous surgery	1.037 (0.783–1.372)	1.293 (0.940–1.778)	1.092 (0.807–1.477)	1.278 (0.758–2.154)	0.577 (0.400–0.834)†
Specialty (vs urology):					
Gynecology	0.712 (0.612–0.829)†	0.966 (0.784–1.188)	0.658 (0.477–0.908)†	0.761 (0.586–0.989)†	1.246 (0.742–2.095)
Other	0.686 (0.488–0.965)†	0.635 (0.445–0.906)†	0.968 (0.631–1.484)	0.514 (0.299–0.885)†	0.800 (0.504–1.270)
UDS vol (No. cases):					
14–90 vs Less than 14	1.373 (1.182–1.595)†	1.854 (1.514–2.271)†	1.273 (0.970–1.670)	1.564 (1.179–2.074)†	1.613 (1.157–2.248)†
Greater than 90 vs less than 14	2.032 (1.635–2.526)†	2.860 (2.208–3.704)†	1.304 (0.964–1.764)	1.638 (1.176–2.282)†	1.723 (1.187–2.501)†

*Total of 2,475 patients excluded from multivariate analysis due to missing data.

†$p < 0.05$.