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Early urodynamic studies after spinal cord injury: time to reconsider clinical practice

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Abstract

Study Design:

Secondary analysis of a prospective clinical trial.

Objectives:

To evaluate whether urodynamic studies (UDS) performed in early spinal cord injury (SCI) identify actionable bladder dysfunction and influence clinical decision-making.

Setting:

Acute inpatient rehabilitation facility in the United States

Methods:

People with SCI admitted within 6 weeks of injury were included. Individuals who consented underwent UDS (UDS group), while those who declined participation served as the comparison (no UDS group). UDS measures included detrusor overactivity, detrusor sphincter dyssynergia, low compliance (≤ 15 mL/cm H2O), cystometric capacity (< 300 mL), and detrusor pressure ≥ 40 cm H2O. High-risk bladder was defined by these abnormalities. Multivariable Firth logistic regression evaluated associations with overactive bladder (OAB) medication use and urinary tract infection (UTI).

Results:

A total of 149 individuals were included (70 no UDS, 79 UDS). Urodynamic abnormalities were identified in 57%. OAB medication use was higher in the UDS group (16% vs 9%). High-risk bladder was associated with OAB medication use (24% vs 6%; OR 4.33, 95% CI, 1.01 to 18.48) and remained significant after adjustment for discharge voiding method (OR 4.58, 95% CI, 1.07 to 19.72). Individuals with high-risk findings were more likely to receive OAB medications than those without UDS (24% vs 9%; OR 3.31, 95% CI, 1.16 to 9.42). UDS exposure was not associated with UTI (OR 1.51, 95% CI, 0.76 to 2.98).

Conclusions:

UDS in early SCI identifies clinically actionable bladder dysfunction and is associated with changes in bladder management. These findings support consideration of urodynamic evaluation during inpatient rehabilitation.

Introduction

Neurogenic lower urinary tract dysfunction (NLUTD) is nearly universal after spinal cord injury (SCI) and is a major contributor to morbidity, including urinary incontinence, urinary retention, urinary tract infections, and long-term upper urinary tract complications[1]. Early management of bladder dysfunction is therefore a critical component of care during acute inpatient rehabilitation.

Urodynamic studies (UDS) are the gold standard for evaluating lower urinary tract function; however, in the United States, they are not routinely performed in individuals with early SCI during acute inpatient rehabilitation. Despite emerging evidence to the contrary, it has long been assumed that UDS provides limited clinical utility in the early phase after injury (presumed spinal shock for months). Multiple studies, including reports dating back to 1998, have consistently demonstrated that neurogenic bladder pathology is present in more than 50% of individuals when UDS is performed within the first weeks after SCI[2–5].

These findings suggest that a substantial proportion of individuals may have clinically actionable bladder dysfunction that remains unrecognized and undertreated with current practice, representing a missed opportunity to optimize early bladder care in SCI. We hypothesized that UDS performed during acute inpatient rehabilitation in early SCI would detect high-risk bladder dysfunction in over 50% of participants and that these findings would result in meaningful changes in bladder management.

Methods

This post-hoc study was conducted at a single acute inpatient rehabilitation facility and derived from individuals screened for an ongoing transcutaneous tibial nerve stimulation prospective trial in early SCI (CT.gov: NCT04350359), from June 2020 to July 2025. People who consented to participate in the parent study underwent baseline UDS and comprised the UDS group. Individuals who met eligibility criteria for the parent study but declined participation did not undergo UDS and comprised the comparison group (no UDS). Institutional Review Board approval was obtained to review medical records of all eligible people, including those who did not consent to the parent study (HSC-MS-24-1097).

Eligible individuals were aged 18–75 years, admitted to acute inpatient rehabilitation within 6 weeks of a non-progressive SCI, had a neurologic level of injury at or above thoracic level 9, and were candidates for clean intermittent catheter-based bladder management. Demographic and clinical variables collected included age, sex, and dates of injury, admission, discharge, and urinary tract infection (UTI) diagnosis. SCI characteristics included neurologic level of injury (NLI) and severity [American Spinal Injury Association (ASIA) Injury Severity (AIS) classification]. Bladder management variables included admission and discharge voiding method, use of overactive bladder (OAB) medications, and voiding method at the time of UDS. Urinary tract infection (UTI) was defined as documentation of signs and symptoms consistent with UTI, a urine culture demonstrating growth of urinary pathogens, and subsequent resolution of symptoms with appropriate antibiotic treatment during the inpatient rehabilitation stay.

UDS were performed according to institutional protocols consistent with International Continence Society standards[6]. UDS were performed as a baseline measure prior to the study interventions and were independently reviewed by two investigators, with discrepancies resolved by consensus. UDS were performed at approximately the same time of day. Urodynamic variables included detrusor overactivity (DO) and detrusor sphincter dyssynergia (DSD), classified as present or absent. Low bladder compliance was defined as ≤ 15 mL/cm H2O, reduced maximum cystometric capacity as < 300 mL, and elevated detrusor pressure as ≥ 40 cm H2O. A “high-risk bladder” variable was defined as the presence of any of these abnormalities.

Descriptive statistics were used to summarize individuals’ characteristics and urodynamic findings. Continuous variables were reported as medians with interquartile ranges and compared using non-parametric tests. Categorical variables were compared using Fisher’s exact test. Multivariable Firth logistic regression was used to evaluate associations between UDS findings and OAB medication use at discharge, as well as the association between UDS exposure and UTI, with additional adjustment for voiding method (at admission or discharge, depending on the model). Covariates were selected a priori based on clinical relevance and included variables that differed between groups at baseline. Statistical significance was defined as $p < 0.05$. Based on observed differences in OAB medication use, a sample size of approximately 250 people would be required to achieve 80% power for between-group comparisons. There were no missing data for the primary variables included in the analyses. All analyses were performed using Stata (StataCorp, College Station, TX).[7] This study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines[8].

Results

We screened 2,056 acute inpatient rehabilitation admissions to the SCI service line. After duplicate people were removed for repeat admissions, there were 1,664 individuals, of which data was available for 79 people that had a UDS (UDS group) and 70 that did not have a UDS (no-UDS group) (Fig. 1).

Baseline demographic and clinical characteristics were similar between groups, with the exception of age, which was lower in the UDS group (median 41 vs 51 years, $p = 0.006$) and sex, with a greater percentage of men in the UDS group [n = 67 (85%) v n = 46 (66%), $p = 0.008$] (Table 1). There were no significant differences in days from injury to rehabilitation admission, or SCI characteristics including neurologic level and injury severity. None in this cohort were prescribed OAB medications at admission. For the UDS group, the median days to admission to acute inpatient rehab from injury were 14 days (IQR 11–21) compared to 12 days (IQR 9–20, $p = 0.29$) for the no UDS group. The median days of admission were also similar between UDS and no UDS groups [28 (IQR 22–36) v 28.5 (IQR 22–32), $p = 0.49$, respectively]. For the UDS group, the median days to UDS from injury were 31 (IQR 23–40).

Table 1
Baseline characteristics by UDS groups on admission to inpatient rehabilitation

	No UDS group		**UDS group**		
	n = 70		**n = 79**		
Variable	**Median**	**IQR**	**Median**	**IQR**	**p-value**
Age	51	36–63	41	24–55	**0.006**
Baseline Creatinine (mg/dl)	0.65	0.56–0.79	0.72	0.59–0.83	0.21
Injury to admission (days)	12	9–20	14	11–21	0.29
Length of admission (days)	28.5	22–32	28	22–36	0.49
Injury to UDS (days)	-	-	31	23–40	-
	n	%	**n**	%	
Male	46	66%	67	85%	**0.008**
Tetraplegia	40	57%	36	46%	0.19
AIS					0.4
A	25	36%	38	48%	
B	10	14%	12	15%	
C	12	17%	9	11%	
D	23	33%	20	25%	
Neurologic Level of Injury					0.22
C1-C4	19	27%	15	19%	
C5-C8	21	30%	21	27%	
T1-T4	15	21%	14	18%	
T5-T9	15	21%	29	37%	
Voiding Method					0.09
Foley	43	61%	55	70%	
CIC	23	33%	24	30%	
Spontaneous	4	6%	0	0%	

UDS= urodynamic study; IQR= interquartile range; AIS= ASIA Impairment Scale; C1-8 = cervical levels 1–8; T1-9 = thoracic levels 1–9; CIC= clean intermittent catheterization; OAB= overactive bladder medications;

	No UDS group		UDS group		
	n = 70		n = 79		
Admission OAB medications	0	0%	0	0%	-

UDS= urodynamic study; IQR= interquartile range; AIS= ASIA Impairment Scale; C1-8 = cervical levels 1–8; T1-9 = thoracic levels 1–9; CIC= clean intermittent catheterization; OAB= overactive bladder medications;

At discharge, individuals in the UDS group were prescribed OAB medications nearly twice as frequently as the no-UDS group (16% vs 9%, p = 0.22) (**Table 2**). Also, the no-UDS group had a greater proportion of individuals managed with an indwelling catheter and a higher rate of spontaneous voiding. In adjusted analyses accounting for age, sex, and discharge voiding method, UDS exposure was not significantly associated with OAB medication use at discharge (OR 1.54, 95% CI, 0.54 to 4.39).

Table 2. Discharge outcomes by UDS group

	No UDS group		UDS group		
	n=70		n=79		
Variable	**n**	%	**n**	%	**p-value**
Voiding Method					**0.017**
Foley	32	46%	26	33%	
CIC	26	37%	47	59%	
Spontaneous	12	17%	6	8%	
Discharge OAB medications	6	9%	13	16%	0.22
Urinary tract infection (UTI)	34	49%	45	57%	0.33
UTI prior to UDS	-	-	26	58%	-

UDS= urodynamic study; IQR= interquartile range; AIS= ASIA Impairment Scale; C1-8= cervical levels 1-8; T1-9= thoracic levels 1-9; CIC= clean intermittent catheterization; OAB= overactive bladder medications;

Among people undergoing UDS, urodynamic abnormalities were identified in 45/79 (57%) (**Table 3**). DO was present in 43/79 (54%), DSD in 18/79 (23%), low bladder compliance in 14/79 (18%), reduced maximum cystometric capacity in 18/79 (23%), and elevated detrusor pressure in 23/79 (29%). High-risk

bladder, defined as the presence of any of the former abnormal urodynamic parameters, had a lower percentage of people with tetraplegia [16 (36% v 20 (59%), p = 0.044]. High-risk bladder was associated with OAB medication use at discharge (11/45 [24%] vs 2/34 [6%]; OR 4.33, 95% CI 1.01 to 18.48). This association remained similar in magnitude after adjustment for discharge voiding method and tetraplegia but was attenuated with wider confidence intervals (OR 4.11, 95% CI, 0.95 to 17.66). People with high-risk findings were also more likely to be discharged on OAB medications compared to the no-UDS group (24% vs 9%; OR 3.31, 95% CI 1.16 to 9.42).

Table 3. Characteristics and urodynamic findings by high-risk bladder status

	Low-risk bladder		**High-risk bladder**		
	n=34		**n=45**		
Variable	**Median**	**IQR**	**Median**	**IQR**	**p-value**
Age	43	25-60	40	24-54	0.42
Injury to admission (days)	14	12-21	15	11-22	0.91
Length of admission (days)	27	20-31	28	23-44	0.18
Baseline Creatinine	0.74	0.59-0.85	0.72	0.59-0.8	0.71
Injury to UDS (days)	27.5	21-37	32	23-42	0.21
	n	%	**n**	%	
Male	29	85%	38	84%	1
Tetraplegia	20	59%	16	36%	**0.044**
AIS					0.11
A	14	41%	24	53%	
B	5	15%	7	16%	
C	2	6%	7	16%	
D	13	38%	7	16%	
Neurologic Level of Injury					0.14
C1-C4	10	29%	5	11%	
C5-C8	10	29%	11	24%	
T1-T4	4	12%	10	22%	
T5-T9	10	29%	19	42%	
Voiding Method day of UDS					0.46
Foley	12	35%	19	42%	
CIC	22	65%	24	53%	
Spontaneous	0	0%	2	4%	
Detrusor Overactivity	0	0%	43	96%	
DSD	0	0%	18	40%	

High detrusor pressure	0	0%	23	51%
Low bladder capacity	0	0%	18	40%
Low compliance	0	0%	14	31%

UDS= urodynamic study; IQR= interquartile range; AIS= ASIA Impairment Scale; C1-8= cervical levels 1-8; T1-9= thoracic levels 1-9; CIC= clean intermittent catheterization; OAB= overactive bladder medications; DSD= detrusor sphincter dyssynergia

Urinary tract infection occurred in 33/70 (47%) individuals in the no-UDS group and 45/79 (57%) in the UDS group (p = 0.253) (**Table 2**). Among people undergoing UDS, the majority of UTIs occurred prior to UDS (26/45, 58%). In adjusted analyses accounting for admission voiding method, age, and sex, UDS exposure was not associated with UTI (OR 1.51, 95% CI, 0.76 to 2.98).

Discussion

In this study of individuals with early SCI undergoing inpatient acute rehabilitation, urodynamic evaluation identified clinically actionable lower urinary tract dysfunction in the majority of individuals. More than half of those undergoing UDS demonstrated abnormal findings, challenging the traditional assumption of spinal shock and consistent with smaller reports in the literature. These findings were strongly associated with initiation of OAB pharmacotherapy at discharge. Importantly, UDS exposure was not associated with an increased risk of urinary tract infection, and the majority of UTIs in the UDS group occurred prior to testing. Together, these findings suggest that UDS early in SCI (within six weeks of injury) provides clinically meaningful information that can inform bladder management without clear evidence of harm.

The prevalence of urodynamic abnormalities in this cohort (57%) is consistent with prior studies demonstrating that neurogenic bladder dysfunction is present early after SCI, even with concerns regarding spinal shock [2–5]. However, existing studies are limited by small sample sizes, are largely derived from European cohorts, and predate contemporary rehabilitation practice in the United States. In addition, most prior studies have been descriptive and have not included a comparison group or evaluated the impact of urodynamic findings on clinical management. The present study extends this literature by providing contemporary data from a U.S. inpatient rehabilitation setting, incorporating a comparison group of individuals who did not undergo UDS, and demonstrating that early urodynamic findings are not only prevalent but are associated with clinically meaningful decision making around bladder management and care. These findings strengthen the evidence that clinically significant pathology is present during the acute rehabilitation phase and may not be reliably identified based on symptoms alone.

A key finding of this study is that clinical management was driven by the identification of high-risk bladder physiology rather than exposure to UDS itself. Individuals with high-risk urodynamic findings

were more than four times as likely to be discharged on OAB medications compared to those without high-risk findings, and this association remained significant after adjustment for discharge voiding method. In contrast, UDS exposure alone was not associated with OAB medication after adjustment, indicating that treatment decisions were guided by the presence of clinically actionable abnormalities rather than the performance of the test. OAB medication use was selected as a measurable marker of treatment; however, urodynamic findings also informed other aspects of bladder management, including adjustments to catheterization frequency and person-specific strategies based on bladder sensation and pressure. These additional recommendations were not systematically captured and may underestimate the overall clinical impact of urodynamic evaluation. Together, these findings highlight that the value of UDS lies in identifying individuals with high-risk bladder dysfunction who may benefit from targeted intervention.

Adjustment for discharge voiding method was included given its close relationship to symptom presentation, as individuals managed with indwelling catheters may not exhibit symptoms such as incontinence that would prompt initiation of OAB pharmacotherapy. Similarly, tetraplegia was included as a clinically relevant covariate, as injury level may influence bladder management strategies through its impact on functional independence and catheterization ability. Although these adjustments attenuated the association between high-risk bladder and OAB medication use, the magnitude of effect remained similar, supporting the robustness of the observed relationship between urodynamic findings and clinical decision-making.

Importantly, concerns regarding the safety of UDS in early SCI were not supported by our findings. Although UTI rates were numerically higher in the UDS group, this difference was not significant, and most UTIs occurred prior to UDS. These data suggest that UDS does not meaningfully contribute to UTI risk in this population and should not be avoided solely due to concerns about infection.

There remains uncertainty in clinical guidance regarding the timing of initial urodynamic testing after SCI. While major societies consistently identify urodynamics as essential for evaluating lower urinary tract dysfunction, they differ in how they address timing, and in many cases defer to clinical judgment rather than providing specific recommendations. In the United States, this has translated into a pattern in which UDS is often delayed until outpatient follow-up, typically performed 6–12 months after injury. The International Continence Society, Japanese Urological Association, and Paralyzed Veterans of America guidelines do not specify a recommended time for initial urodynamic evaluation after SCI[9–11]. In contrast, the American Urological Association/Society of Urodynamics, Female Pelvic Medicine and Urogenital Reconstruction guideline recommends delaying UDS until spinal shock has resolved, typically 3–6 months after injury, and in some cases years[12]. The European Association of Urology suggests that urodynamic evaluation may be performed within 3 months of injury[13]. As a result, clinicians are often left to balance historical misconceptions and theoretical concerns about early urodynamic testing against the risk of missing clinically significant high-risk UDS features.

A broader implication of these findings is that the overall framework of bladder management in SCI has changed relatively little since the introduction of catheter-based management and, in particular, clean intermittent catheterization in the 1970s[14]. Although these advances, together with improved surveillance, have substantially reduced upper urinary tract deterioration and renal-related mortality, neurogenic bladder remains a persistent source of morbidity in SCI[1]. This suggests that current management is still largely reactive, with intervention often occurring only after clinically evident complications develop. In addition to clinical practice patterns, system-level factors, including reimbursement structures during inpatient rehabilitation, may further reinforce this reactive approach by creating disincentives for early urodynamic evaluation. Earlier identification of high-risk bladder physiology may provide an opportunity to move beyond this longstanding paradigm and reduce bladder-related morbidity through more timely and targeted intervention.

This study should be interpreted in the context of several limitations. As a secondary analysis of a prospective clinical trial, the comparison group consisted of individuals who declined participation in the parent study, which may introduce selection bias. Although baseline characteristics were largely similar between groups, unmeasured confounding may remain. In addition, outcome assessment relied on documentation in the medical record, which may introduce misclassification or information bias. Additionally, the sample size was modest, limiting statistical power to detect differences in some outcomes, particularly in adjusted analyses. A majority of individuals in the UDS group were also undergoing tibial nerve stimulation, an intervention intended to reduce overactive bladder symptoms, which may have reduced the likelihood of OAB medication use at discharge. As such, the observed associations may represent conservative estimates of the effect of urodynamic findings on clinical management. Restriction to injuries at or above thoracic level 9 resulted in a cohort largely representing upper motor neuron bladder physiology, providing a more homogeneous population. However, these findings may not be generalizable to individuals with lower motor neuron bladder dysfunction. Finally, this was a single-center study, which may limit generalizability to other acute inpatient rehabilitation centers.

In summary, UDS in early SCI identifies clinically important bladder dysfunction in a substantial proportion of individuals and is associated with changes in bladder management without evidence of increased UTI risk. These findings suggest that deferring urodynamic evaluation until outpatient follow-up may delay identification of treatable pathology during a critical period of care. Earlier diagnosis of high-risk bladder physiology may enable more targeted and timely intervention, with the potential to reduce downstream morbidity related to neurogenic bladder. Incorporating urodynamic evaluation into acute inpatient rehabilitation may therefore improve the precision and timing of bladder management in SCI. These findings support the need for further research on whether early identification and targeted intervention translate into improved long-term outcomes, ideally through multicenter studies.

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Declarations

Ethical Approval:

This study was conducted in accordance with the Declaration of Helsinki and was approved by the Institutional Review Board of [Institution Name] (HSC-MS-24-1097). The parent clinical trial (ClinicalTrials.gov Identifier: NCT04350359) also received Institutional Review Board approval. The requirement for informed consent was obtained for participants enrolled in the parent study, and approval was granted to review data from eligible individuals who declined participation.

Competing Interests:

The authors declare no competing financial interests.

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Author Contributions:

AS conceived and designed the study, performed and interpreted the urodynamic studies, performed the analyses, and drafted the manuscript. RK interpreted the urodynamic studies, reviewed the analyses, and contributed to the manuscript. DG contributed to data management and critically revised the manuscript. HLH contributed to data collection and critically revised the manuscript. SLG contributed to study design, review of the analyses, and manuscript development. All authors reviewed and approved the final manuscript.

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References

1. Milligan, J., L.L. Goetz, and M.J. Kennelly, *A Primary Care Provider's Guide to Management of Neurogenic Lower Urinary Tract Dysfunction and Urinary Tract Infection After Spinal Cord Injury*. Top

Spinal Cord Inj Rehabil, 2020. 26(2): p. 108–115.
2. Watanabe, T., et al., *High incidence of occult neurogenic bladder dysfunction in neurologically intact patients with thoracolumbar spinal injuries*. The Journal of urology, 1998. 159(3): p. 965–8.
3. Bellucci, C.H., et al., *Acute spinal cord injury–do ambulatory patients need urodynamic investigations?* J Urol, 2013. 189(4): p. 1369–73.
4. Bywater, M., et al., *Detrusor Acontractility after Acute Spinal Cord Injury-Myth or Reality?* J Urol, 2018. 199(6): p. 1565–1570.
5. Anderson, C.E., et al., *Temporal development of unfavourable urodynamic parameters during the first year after spinal cord injury*. BJU Int, 2023. 131(4): p. 503–512.
6. Rosier, P., et al., *International Continence Society Good Urodynamic Practices and Terms 2016: Urodynamics, uroflowmetry, cystometry, and pressure-flow study*. Neurourol Urodyn, 2017. 36(5): p. 1243–1260.
7. StataCorp LLC, *Stata Statistical Software: Release 14*. 2015, College Station, TX: StataCorp LLC.
8. von Elm, E., et al., *The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies*. J Clin Epidemiol, 2008. 61(4): p. 344–9.
9. Schurch, B., et al., *Urodynamics in patients with spinal cord injury: A clinical review and best practice paper by a working group of The International Continence Society Urodynamics Committee*. Neurourol Urodyn, 2018. 37(2): p. 581–591.
10. Sekido, N., et al., *Clinical guidelines for the diagnosis and treatment of lower urinary tract dysfunction in patients with spinal cord injury*. Int J Urol, 2020. 27(4): p. 276–288.
11. *Bladder management for adults with spinal cord injury: a clinical practice guideline for health-care providers*. J Spinal Cord Med, 2006. 29(5): p. 527–73.
12. Ginsberg, D.A., et al., *The AUA/SUFU Guideline on Adult Neurogenic Lower Urinary Tract Dysfunction: Diagnosis and Evaluation*. J Urol, 2021. 206(5): p. 1097–1105.
13. Sartori, A.M., et al., *Summary of the 2024 Update of the European Association of Urology Guidelines on Neurourology*. Eur Urol, 2024. 85(6): p. 543–555.
14. Lapides, J., et al., *Clean, intermittent self-catheterization in the treatment of urinary tract disease*. J Urol, 1972. 107(3): p. 458–61.

Figures

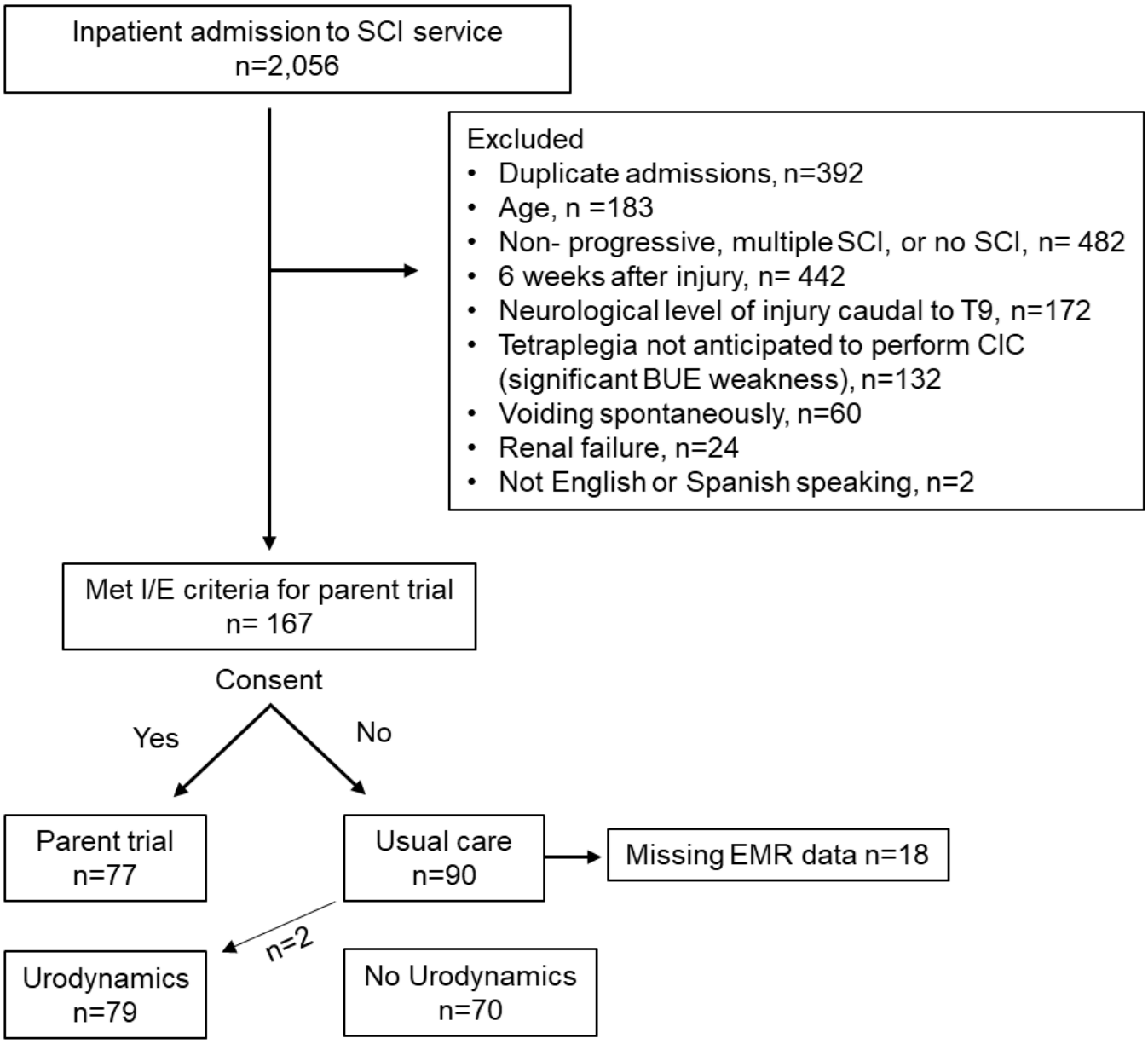


Figure 1

Flow diagram of cohort selection and study inclusion. Acute inpatient rehabilitation admissions to the spinal cord injury (SCI) service were screened, duplicate admissions were removed, and individuals meeting eligibility criteria for the parent clinical trial were identified. Participants who consented underwent urodynamic studies (UDS group), while eligible individuals who declined participation comprised the comparison group (no UDS group). Two individuals in the no UDS group underwent urodynamic testing as part of usual clinical care. Participant numbers at each stage are shown.

Supplementary Files

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- EarlyUDSSTROBEchecklistv4combined.docx