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REVIEW

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Evaluating methods of detecting and determining the type of urinary incontinence in adults after stroke: A systematic review

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Abstract

Introduction: Urinary incontinence (UI) affects over half of people with stroke. It is unclear which methods are accurate in assessing presence and type of UI to inform clinical management. Diagnosis of UI based on inaccurate methods may lead to unnecessary interventions. The aims of this systematic review were to identify, for adults with stroke, clinically accurate methods to determine the presence of UI and type of UI.

Method: We searched seven electronic databases and additional conference proceedings. To be included, studies had to be primary research comparing two or more methods, or use a reference test.

Results: We identified 3846 studies with eight eligible for inclusion. We identified 11 assessment methods within the eight studies. Only five studies had sufficient comparator data for synthesis. Due to heterogeneity of data, results on the following methods were narratively synthesized: Core Lower Urinary Tract Symptom Score (CLSS), clinical history and physical examination, Barthel Activities of Daily Living Index, International Consultation Incontinence Questionnaire Short Form (ICiQ-SF) and urodynamic studies (UDS). Most studies were small and of low to medium quality. All reported differences in sensitivity, and none compared the same assessment methods.

Conclusion: Current evidence is insufficient to support recommendations on the most accurate UI assessment for adults with stroke. Further research is needed.

KEYWORDS

accuracy, assessment methods, effectiveness, stroke, urinary incontinence, urinary incontinence symptoms

1 | INTRODUCTION

Urinary incontinence (UI), defined as involuntary or unintentional loss of urine, is common after stroke.[1] More than half of people with stroke will be incontinent during the first month, 38% remaining incontinent after 1 year, and 17% longer-term.[2,3] Stroke can cause UI or, if a person has pre-existing UI or lower urinary tract symptoms (LUTS), it can worsen after stroke.[4] Stroke severity, older age, female sex, and problems with speech, motor, visual fields, or cognition increase the likelihood of UI.[5,6]

The impact of UI after stroke is wide-reaching. It affects quality of life, including mood, confidence, self-image, ability to participate in rehabilitation, and social activities.[7–9] It is associated with increased healthcare expenditure and worse outcomes, including greater mortality, morbidity, and likelihood of being discharged into institutional care.[10,11] Additionally, UI after stroke has a huge impact on carer burden.[9]

UK guidance[12,13] recommends standardized assessment of UI after stroke; however, there is a lack of stroke-specific evidence, and current guidance is informed by research predominately conducted in the nonstroke population with only two known stroke-specific trials.[14,15] Furthermore, associated stroke impairments, such as motor, visual, or speech problems, compound difficulties with assessment, making generic UI assessment methods a challenge.[16] If a diagnosis of UI is based on inaccurate methods, then patients may receive ineffective and unnecessary interventions. National UK audit data suggest that, even with the available guidance, clinicians are unable to distinguish between types of UI, and poststroke UI is poorly managed.[17,18]

A systematic review evaluating methods of assessing UI in the general adult population was conducted in 2002.[19] A review focussing specifically on the needs of people with stroke is required to determine which assessment methods are most accurate considering how stroke-related impairments complicate UI assessment. Therefore, the aim of this systematic review was to evaluate the diagnostic performance of assessment methods used to determine the presence and type of UI after stroke, evaluate the quality of evidence and to identify areas for further research.

2 | METHODS

2.1 | Search strategy and selection criteria

The search strategy was developed and piloted with an information specialist (C. H.). We used previous systematic review searches and Cochrane Search Strategies to identify search terms.[19,20] Keywords were identified through relevant papers and expertise of co-authors. Using the strategy (Supporting Information: Figure 1), we searched Medline (Ovid), Embase (Ovid), CINAHL (EBSCOhost), PsycINFO (EBSCOhost), AMED (EBSCOhost), Cochrane Library via Wiley (all databases), and International HTA Database (https://www.inahta.org/hta-database/) up to February 2022. The strategy was developed in Medline and adapted across the remaining databases. Due to resource limitations, the searches were limited to the English language. We used simpler terms (stroke and cerebrovascular accident) to search conference proceedings of the International Continence Society (ICS) to January 2022 (https://onlinelibrary.wiley.com/).

The study protocol was registered on PROSPERO CRD42022333376[21] and followed PRISMA guidelines[22] (Supporting Information: Table 1). Duplicate records were removed in EndNote and Rayyan online collaborative systematic review software[23] was used for record management and screening. The reference lists of included records were screened to identify additional papers.

We included records published in peer-reviewed journals comparing (i) detection or (ii) diagnostic methods of UI in stroke survivors aged 18 or over. Included records were primary research evaluating assessment methods (e.g., clinical use, sensitivity, specificity, predictive value, measures of effect) with a reference test or, in the absence of a reference test, comparison between different assessment types. Studies involving any country and conducted in any setting were included. Studies were excluded if participants had neurogenic UI for reasons other than stroke, had recently given birth, or undergone recent gynecological or urological surgery. Two reviewers (C. G. & C. D.) independently screened records; any discrepancies were discussed with a third reviewer (A. S.) to reach consensus. We attempted to contact authors where required stroke-specific data or comparator data were missing. If the data was not provided, the paper was excluded.

2.2 | Quality assessment

We evaluated the methodological quality of the included cohort and case-control studies using the eight-item Newcastle-Ottawa Scale (NOS).[24,25] The quality of cross-sectional studies were assessed using the eight-item Joanna Briggs Institute (JBI) Critical Appraisal Tool for cross-sectional studies.[26] A higher score (maximum of 9) indicates higher quality.

2.3 | Data extraction

Data extraction was piloted by three independent reviewers (C. G., C. D., & A. S.) until consensus was reached. The categories of data extracted are available in Supporting Information: Table 2.

2.4 | Synthesis methods

Our initial meta-analysis plan is detailed in our published PROSPERO protocol.[21] Due to the wide heterogeneity in the methods, interventions and participant characteristics of included studies, a quantitative meta-analysis was not feasible. Therefore, a narrative synthesis was framed around three elements: (1) Preliminary synthesis of similarities and differences across studies; (2) Exploring relationships in the data; (3) Assessing robustness of synthesis and strength of evidence. The PROSPERO protocol[21] was updated with the updated synthesis plan in September 2022.

3 | RESULTS

3.1 | Study selection

Figure 1 presents the PRISMA diagram depicting the review phases. We identified 3839 records through database searches and 7 records from searching citations and conference proceedings. After removing duplicates, 2517 records were screened. Fifty-three papers were eligible for full-text review. Most full-text exclusions were from lack of comparison data between assessment methods (see Table 1). Nine studies in 10 records met the eligibility criteria. One study (Itoh)[27] was later excluded because we were unable to contact the author to obtain stroke-specific data from a mixed sample.

3.2 | Study characteristics

Table 2 provides a summary of the included studies. Most studies (62.5%, $n = 5$) were published in the last decade 2012–2022, and one each (12.5%) in 2007, 1997, and 1996.

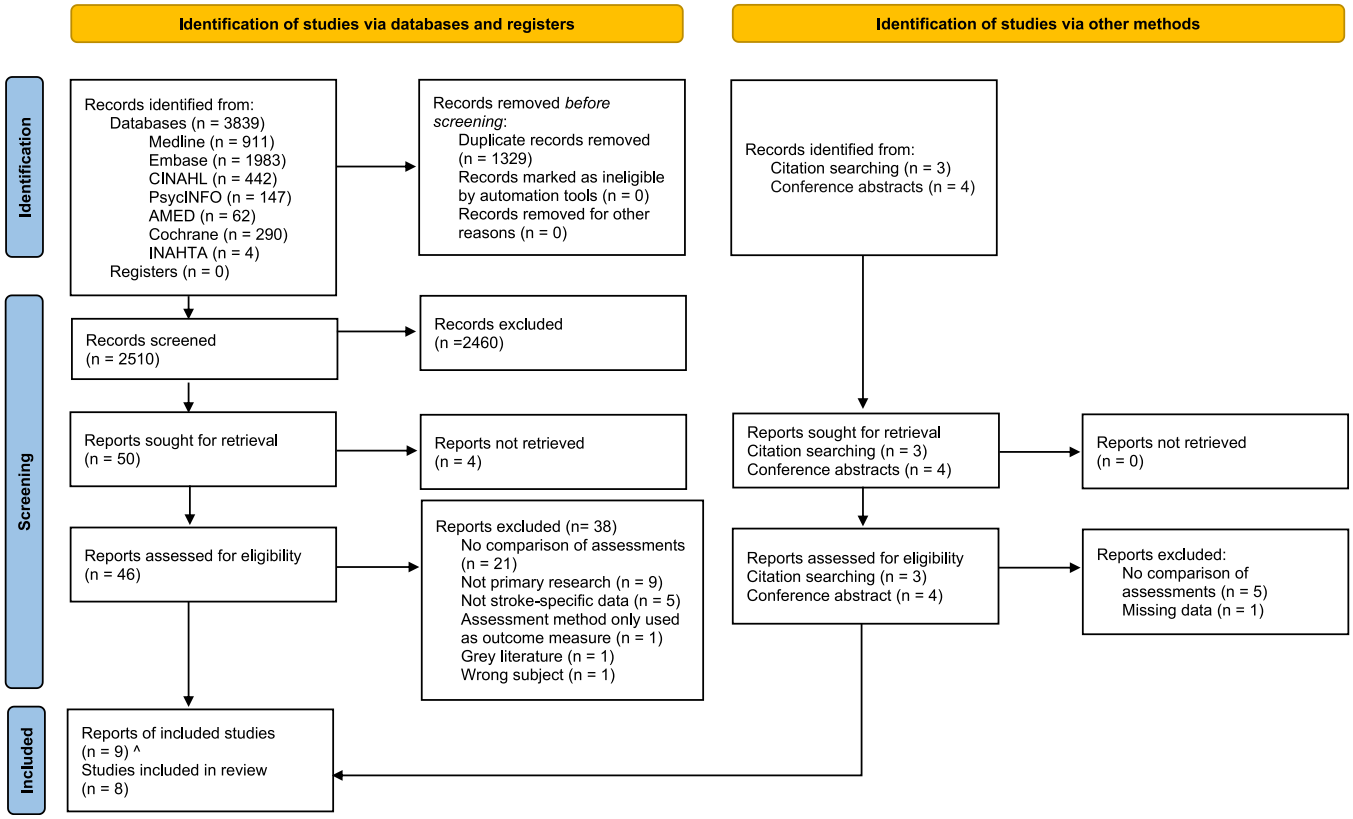

FIGURE 1 PRISMA diagram to show the flow of study exclusions and final included studies.[22] ^Tibaek[33] was checked for additional detail to support Tibaek.[45]

TABLE 1 Studies meeting the inclusion criteria and excluded, with reasons why.

References	Reasons for exclusion
Guo[15]	No comparison between two (or more) assessment methods
Jordan[28]	
Kim[29]	
Burney[30]	
Brittain[31]	
Miyazato[32]	
Tibaek[33]	
Tibeak[34]	
Herr-Wilbert[35]	
Pyo[36]	
Vaughn[37]	
Akkoc[38]	
Leandro[39]	
Kawakami[40]	
Sogbein[41]	Unable to extrapolate stroke specific data from mixed sample
Itoh[42]	

Three studies were conducted in Europe,[43-45] three in Asia,[46–48] and one in the United States.[49] Only one study had the primary objective to validate assessment methods in a stroke population.[50] One study recruited from two sites,[50] and the remaining six were single-center observational studies: three were cross-sectional design[45,48,50] one was case-control[49] and four cohort studies.[43,44,46,47] Five were conducted in hospital settings, two in urology departments, and one in a survey in participants' homes (Tables 2 and 5). In total, 795 participants from eight studies were included for analysis.

3.3 | Study quality and risk of bias

See Tables 3 and 4 for a summary of methodological quality assessment. For both assessment tools, a higher score (maximum of 9) indicated higher quality, and the reviewers considered a score of >7 indicated good quality with low risk of bias.

Table 3 shows the quality assessment for cohort and case-control studies ($n = 5$). Four out of the five studies demonstrated a moderate to high risk of bias. All studies underreported on how participants were initially identified with LUTS or UI. Ishigooka[46] lost points on lack of reporting their criteria for identifying participants, stroke impairments and time from stroke onset to assessment. Pettersen[43] lost points due to heterogeneity between groups and lack of adjustment of variables for analysis. Lee et al.'s study[47] was underpowered with small sample size, selection bias from recruiting young participants from one rehabilitation hospital, and a lack of reporting on assessor blinding. Nitti et al.'s study[49] had selection bias through recruitment of males only referred for urology assessment, and a wide range from stroke onset to assessment with underreporting on stroke characteristics leading to difficulty in determining comparability. Finally, Pizzi et al.[44] had 40% loss at follow-up with a short follow-up period. Regarding the three cross-sectional studies (Table 4), their quality ranged from 4 (high risk of bias) to 7 (low risk of bias). All three studies did adjust for confounding factors in their analysis. Tibaek et al.'s study[45] scored low because a gold standard assessment was not used, and two assessments relied on self-reporting of symptoms with wide variations in assessment timing. Yeşil's study[50] also lost points as it did not use a gold standard assessment for validation of their assessment method.

3.4 | Participant characteristics

A summary of the participant characteristics is provided in Table 5. One study reported incomplete data on participant age, reporting only a subset of participants.[43] The mean age was 67.4 years for 768 participants. Forty-three percent of participants were female. One study only recruited males.[49] When this was excluded, the proportion of females remained similar at 44.5%. Not all studies reported presence of UI before stroke nor current incontinence management.

3.4.1 | Stroke severity/level of disability

Two studies did not assess participants' poststroke impairments or disability.[46,49] Due to differences in impairment and functional assessments used, we were unable to directly compare stroke severity between studies. We reviewed the mean neurological impairment and functional assessment scores at baseline and concluded that: four studies included patients predominately with moderate stroke severity or disability[43,45,48,50]; one study included participants with predominantly mild stroke severity[47]; and one included participants with mainly severe disability at baseline assessment.[44] We were unable to ascertain how stroke severity or disability impacted on the continence assessment.

TABLE 2 Summary of included studies.

References	Study aim	Research design	Population (Country; *N* participants with stroke, mean age [range], % female)	Setting	Stroke Type: Infarction (I)/ Hemorrhage (H) (%)	Stroke severity/ disability	Type of UI Assessment	Results relevant to review questions
Ishigooka[46]	To investigate factors causing a negative ice water test in patients with overactive bladder and stroke.	Retrospective cohort	Japan; $N = 32$; 69.1 years ±1.9; 44%	One urology departm-ent	NR	NR	1. Urodynamic study (UDS) 2. Ice water test (IWT)	Nonsignificant association of higher maximum detrusor pressure in the positive IWT group compared with patients with negative IW. The threshold bladder volume at involuntary detrusor contraction was significantly lower in the positive IWT group than in the negative IWT group ($p < 0.05$). 62.5% of the patients with overactive bladder due to stroke had a positive IWT.
Lee[47]	To investigate urological disturbances by correlating urodynamics, brain imaging, and urological symptoms questionnaire in consecutive patients with chronic	Retrospective cohort	Korea; $N = 20$; 54.4 years ±10.9; 25%	One inpatient stroke unit	I: $N = 12$ (60) H: $N = 8$ (40)	Mean (SD) NIHSS = 3.3 (1.7)	1. UDS 2. International Prostate Symptom Score (IPSS) 3. Barthel Index (BI) (continence subscore) 4. Clinical history and examination	UI assessed by BI continence subscore was reported in two patients—a UI rate of 10% (less than the general stroke population). At least one LUTS from the IPSS was reported by $N = 19$

(Continues)

TABLE 2 (Continued)

References	Study aim	Research design	Population (Country; *N* participants with stroke, mean age [range], % female)	Setting	Stroke Type: Infarction (I)/ Hemorrhage (H) (%)	Stroke severity/ disability	Type of UI Assessment	Results relevant to review questions
	brainstem stroke admitted for rehabilitation.							out of 20 participants.Patients with pontine strokes had higher IPSS–voiding, IPSS–storage and total scores than patients with midbrain and medullary strokes. There was no difference between ischemic and hemorrhagic brain stem stroke regarding UDS results and urological symptoms.
Nitti[49]	To determine the role of urodynamics in the evaluation of voiding dysfunction in men after stroke.	Retrospective case control	USA; *N* = 38;70 years [54–87]; 0%	One urology departm-ent	NR	NR	1. UDS 2. Clinical history and examination	In 89%, the onset of LUTS paralleled stroke onset. 82% had detrusor hyperreflexia occurred in 82%. There was no statistically significant difference in the occurrence of detrusor hyperreflexia among irritative, obstructive or

TABLE 2 (Continued)

References	Study aim	Research design	Population (Country; *N* participants with stroke, mean age [range], % female)	Setting	Stroke Type: Infarction (I)/ Hemorrhage (H) (%)	Stroke severity/ disability	Type of UI Assessment	Results relevant to review questions
								mixed symptom groups (Fisher's exact test). Pressure-flow analysis showed obstruction in 63%, no obstruction in 24% and equivocal results in 13%. Based on comprehensive history and physical examination of each patient: UI type was diagnosed as: 1. Irritative 16 (42%) 2. Obstructive 13 (34%) 3. Mixed 9 (24%) Clinical history and examination are not as sensitive as UDS. Presenting clinical symptoms did not predict the urodynamic findings of bladder outlet obstruction or detrusor hyperreflexia.

(Continues)

TABLE 2 (Continued)

References	Study aim	Research design	Population (Country; *N* participants with stroke, mean age [range], % female)	Setting	Stroke Type: Infarction (I)/ Hemorrhage (H) (%)	Stroke severity/ disability	Type of UI Assessment	Results relevant to review questions
Özcan[48]	To determine the factors affecting LUTS severity in stroke patients and to evaluate the relationship between LUTS severity and urodynamic study data.	Cross-sectional	Turkey; $N = 77$ ($N = 33$ underwent UDS; 65.99 years [33–88]; 51.9%	One inpatient rehabilitation unit	I: $N = 65$ (84.4) H: $N = 12$ (15.6)	Mean (SD) FIM = 75.3 (22.7)	1. UDS 2. IPSS 3. Core Lower Urinary Tract Symptom Score (CLSS) 4. Overactive Bladder Symptom Score 5. FIM	The mean CLSS of all patients was 11.81 (5.09) (median: 11, min-max: 1–26). There was a significant negative correlation between total FIM, and all FIM subparameter scores, and CLSS mean ($p = 0.001$, $r = -0.467$). A subgroup of $N = 33$ underwent UDS. Mean CLSS of UDS group was 12.9 (4.01) and significantly higher than non UDS group (10.3 (5.3), $p = 0.007$). There was no significant relationship between presence of LUTS, detrusor type, detrusor sphincter dyssynergia and CLSS. A significant negative correlation was found between maximum flow rate and CLSS ($p = 0.043 r = -0.354$).

TABLE 2 (Continued)

References	Study aim	Research design	Population (Country; *N* participants with stroke, mean age [range], % female)	Setting	Stroke Type: Infarction (I)/ Hemorrhage (H) (%)	Stroke severity/ disability	Type of UI Assessment	Results relevant to review questions
Pettersen[43]	To describe a clinical subtype of poststroke UI (with impaired awareness of the need to void (IA-UI)) and to compare it to poststroke urge UI in terms of the risk factors and medium-term outcome.	Cohort	Norway; $N = 65$ ($N = 7$ underwent UDS); mean age not reported for full sample 81 [67–91] for IA-UI group; 55%	One inpatient stroke unit	IA-UI group I: $N = 32$ (84) H: $N = 6$ (16)	Total participant modified Barthel Index <9 on admission $N = 34$ (52%)	1. Diary and observation chart 2. Residual volume (ultrasound) 3. UDS	$N = 27$ developed classic symptoms of urge UI. $N = 38$ had IA-UI: 16 were partially aware of leakage, but not of bladder fullness; the remaining 22 denied leakage, despite objective evidence from diaries. $N = 7$ had a urodynamic assessment: $N = 3$ with denial who acknowledged their UI after information, and $N = 4$ with partial awareness. Two out of three who denied symptoms had normal UDS but felt no desire to void. All four participants with partial awareness showed terminal detrusor overactivity.
Pizzi[44]	To investigate the frequency, the prognostic effect on functional status	Cohort Repeated measures at baseline	Italy; $N = 106$ (T0); $N = 63$ (T1); 72 years ±11.5 (T0); 39% (T0)	One inpatient	I: $N = 106$ (100%)	Mean (SD) Barthel Index at T0 (i)	1. Residual volume (ultrasound) 2. UDS	$N = 111$ out of $N = 133$ ischemic stroke patients were incontinent or

(Continues)

TABLE 2 (Continued)

References	Study aim	Research design	Population (Country; *N* participants with stroke, mean age [range], % female)	Setting	Stroke Type: Infarction (I)/ Hemorrhage (H) (%)	Stroke severity/ disability	Type of UI Assessment	Results relevant to review questions
	and the urodynamic patterns of poststroke UI in a sample of in-patients with ischemic stroke, during the postacute rehabilitative phase.	(T0) and 30 days (T1)		rehabilitation unit		Incontinent group = 24 (20) (ii) Continent group = 33 (26) NIHSS at T0 (i) Incontinent group = 9 (4) (ii) Continent group = 6 (4) FIM at T0 (i) Incontinent group = 47 (21) (ii) Continent group = 61 (26)	3. Clinical history and examination	catheterized at baseline clinical history and examination. *N* = 106 patients had UDS performed at admission (T0), showed normal studies in 15%, detrusor overactivity (DO) in 56%, detrusor overactivity with impaired contractility (DOIC) in 14%, and detrusor underactivity (DU) in 15%. *N* = 63 patients had UDS at T1: normal studies in 30%, DO in 48%, DOIC in 6%, and DU in 16%. UDS findings in patients with ischemic stroke vary depending upon timing of the study. No reporting of residual volume ultrasound results.

TABLE 2 (Continued)

References	Study aim	Research design	Population (Country; *N* participants with stroke, mean age [range], % female)	Setting	Stroke Type: Infarction (I)/ Hemorrhage (H) (%)	Stroke severity/ disability	Type of UI Assessment	Results relevant to review questions
Tibaek[45]	To investigate self-reported prevalence of UI measured by the Barthel Index and the Danish Prostate Symptom Score.	Cross-sectional	Denmark; $N = 407$ respondent group; 67 years ±12; 45%	Participants' home	Respondent group: I: $N = 329$ (81) H: $N = 34$ (8) I + H: $N = 6$ (2)	Respondent group: Mean (SD) Scandinavian neurological stroke scale prognostic score (max 22) = 19 (4)	1. BI 2. Danish Prostate Symptom Score (DAN-PSS-1)	The self-reported prevalence of UI measured by BI was 10.5%, in women 13%, men 8.5%, respectively. In comparison the self-reported prevalence of UI measured by DAN-PSS-1 questionnaire was 49%, in women 60% and in men 41%. There were significantly fewer stroke patients who reported UI by the BI compared with the DAN-PSS questionnaire in term of urge UI ($p < 0.001$), stress UI ($p < 0.001$), and other UI ($p < 0.001$). There was an association between the prevalence of bother in the DAN-PSS-1 and the prevalence of UI by BI ($p < 0.037$).

(Continues)

TABLE 2 (Continued)

References	Study aim	Research design	Population (Country; *N* participants with stroke, mean age [range], % female)	Setting	Stroke Type: Infarction (I)/ Hemorrhage (H) (%)	Stroke severity/ disability	Type of UI Assessment	Results relevant to review questions
Yeşil[50]	To assess the validity and reliability of the Turkish Danish Prostatic Symptom Score in stroke patients with LUTS.	Cross-sectional	Turkey $N = 50$; 66.66 years ±8.72; 42%	Two rehabilitation departments	I: $N = 24$ (48) H: $N = 24$ (48) I + H: $N = 2$ (4)	Mean (SD) Barthel Index = 71.8 (20.2)	1. DAN-PSS-1 2. International Consultation on Incontinence Questionnaire-Short Form (ICiQ-SF) 3. BI	Significant negative correlations were found between the BI and subscores of DAN-PSS-1 ($p < 0.01$). DAN-PSS-1 subscores had a strong positive correlation to the ICiQ-SF final score ($p < 0.01$)—suggesting incontinence negatively affects QoL measured by the ICiQ-SF.

Abbreviations: BI, Barthel ADL Index Score; CiQ-SF, International Consultation on Incontinence Questionnaire-Short Form; CLSS, Core Lower Urinary Tract Symptom Score; DAN-PSS-1, Danish Prostate Symptom Score; FIM, functional independence measure; IA-UI, impaired awareness urinary incontinence; IPSS, International Prostate Symptom Score; LUTS, lower urinary tract symptoms; NIHSS, National Institutes of Health Stroke Scale; NR, not reported; SD, standard deviation; UDS, urodynamic studies; UI, urinary incontinence.

TABLE 3 Newcastle Ottawa (NOS) Rating quality assessment of cohort and case-control studies.[24]

References	Study design	Selection[a]	Comparability[b]	Outcome[c]	Total (out of 9)
Ishigooka[46]	Cohort	**	*	*	4
Lee[47]	Cohort	*	-	***	4
Nitti[49]	Case-control	***	-	**	5
Pettersen[43]	Cohort	****	-	***	7
Pizzi[44]	Cohort	***	*	**	6

[a](i) representativeness of the exposed cohort; (ii) selection of the nonexposed cohort; (iii) ascertainment of exposure; (iv) demonstration that outcome of interest was not present at start of study (maximum score 4*).

[b]comparability of cohorts on the basis of design or analysis (maximum score 2*).

[c](i) assessment of outcome; (ii) was follow-up long enough for outcomes to occur; (iii) adequacy of follow-up of cohorts (maximum score 3*).

TABLE 4 Quality assessment of cross-sectional studies using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist.[26]

	Question								
References	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Total (out of 8)
Özcan[48]	Y	Y	Y	Y	Y	N	Y	Y	7
Tibeak[45]	Y	Y	N	Y	N	N	N	Y	4
Yeşil[50]	Y	Y	N	Y	Y	N	Y	Y	6

Note: Q1. Were the Criteria for Inclusion in the Sample Clearly Defined? Q2. Were the Study Subjects and the Setting Described in Detail? Q3. Was the Exposure Measured in a Valid and Reliable Way? Q4. Were Objective, Standard Criteria Used for Measurement of the Condition? Q5. Were Confounding Factors Identified? Q6. Were Strategies to Address Confounding Factors Stated? Q7. Were the Outcomes Measured in a Valid and Reliable Way? Q8. Was Appropriate Statistical Analysis Used?

Abbreviations: Y, yes; N, no.

TABLE 5 Participant characteristics.

Characteristic	Information
Mean age (years)[a]	61.25
Sex (% female)	43
Type of stroke:	
Ischemic	$N = 557$
Intracerebral hemorrhage	$N = 78$
Other/mixed	$N = 160$
Time from stroke onset to assessment	1 week to 12 years
Assessment setting:	
Stroke unit	$N = 2$
Rehabilitation (inpatient/outpatient)	$N = 3$
Urology department	$N = 2$
Home	$N = 1$

[a]Calculated on 768 participants.

3.4.2 | Cognitive and communication impairment

Due to the reliance on patient-reporting of urinary symptoms, patients with poststroke cognitive and communication impairment were less likely to be recruited. These impairments were cited by two studies as reasons for exclusion.[47,48] Two studies excluded participants who were unable to communicate.[43,44] Pettersen's study[43] specifically included participants with cognitive impaired awareness of LUTS. Three studies[45,49,50] did not cite cognitive and communication impairment as a reason for exclusion, but one study used a survey data collection method that would self-select participants with less severe cognition and communication ability.[45] Therefore, patients with severe cognitive and communication impairment are underrepresented in the data.

3.4.3 | Timing of assessment

There was wide variation in the mean time from stroke onset to assessment, ranging from 1 week to 12 years. One study[46] ($n = 32$, 4%) did not report timing of assessment. Five studies ($n = 592$, 74.5%) recruited patients after 4 weeks poststroke and two ($n = 171$, 21.5%) recruited patients less than 4 weeks poststroke.

3.4.4 | Type of LUTS and incontinence

All studies included patients with LUTS, such as urgency or incomplete emptying, with or without incontinence. Due to different measures and terms used, we were unable to extrapolate data on type of UI or LUTS, and therefore our results report on assessment of both.

Overall, the data reported patients have mixed symptoms. LUTS were more common than incontinence.

3.5 | Assessment methods

We identified 11 different assessment methods (see Table 6). These included: (a) six lower urinary tract-specific symptom scores—the Core lower Urinary Tract Symptom Score (CLSS), the Danish Prostate Symptom Score (DAN-PSS), the International Prostate Symptom Score (IPSS), the International Consultation Incontinence Questionnaire Short Form (ICiQ SF) and a micturition diary, one assessment of activities of daily living (ADLs) including an incontinence item (BI); (b) three instrumental assessments—the Ice Water Test (IWT), Urodynamic Studies (UDS), and the Residual Volume Bladder Scan; and (c) Clinical History and Physical Examination. Five studies[45,46,48–50] had sufficient comparator data on 560 patients to be included in

TABLE 6 Type of assessment methods and comparators.

Assessment	Comparators (study lead author)
Lower urinary tract symptom score	
Core Lower Urinary Tract Symptom Score (CLSS)	IPSS (Özcan)[48]
	UDS (Özcan)[48]
Danish Prostate Symptom Score (DAN-PSS)	*BI: continence item (Tibaek)*[45]
	BI: total score (Yeşil)[50]
	ICiQ-SF (Yeşil)[50]
International Consultation Incontinence Questionnaire Short From (ICiQ-SF)	DAN-PSS (Yeşil)[50]
	BI: total score (Yeşil)[50]
International Prostate Symptom Score (IPSS)	UDS (Özcan/Lee)[47,48]
Micturition diary	Residual volume bladder scan (Pettersen)[43]
Activities of daily living score	
Barthel activities of Daily Living Index (BI): total score	DAN-PSS (Yeşil)[50]
Barthel activities of Daily Living Index: continence item only	UDS (Lee)[47]
	IPSS (Lee)[47]
	Clinical history and physical examination (Lee)[47]
Instrumental assessment	
Ice water test (IWT)	*UDS (Ishigooka)*[46]
Residual volume bladder scan	Clinical history and physical examination (Pizzi)[44]
Urodynamic study (UDS)	*CLSS (Özcan)*[48]
	Clinical history and physical examination (Nitti)[49]
	Residual volume bladder scan (Pettersen/Pizzi)[43,44]
	IPSS (Özcan/Lee)[47,48]
	BI: continence item (Tibaek)[45]
	IWT (Ishigooka)[46]
Clinical history and assessment	
Clinical history and physical examination	Residual volume bladder scan (Pizzi)[44]
	UDS (Nitti, Pizzi, Lee)[44,47,49]
	BI: continence item (Tibaek)[45]

Note: *Italics* = comparators with sufficient data to be included in synthesis.

our synthesis (highlighted in *italics* in Table 6). 72.7% ($n = 407$) of participants came from one study.[45]

3.5.1 | DAN-PSS compared with BI

Two studies compared the BI with DAN-PSS; one used the total BI[50] and another used only the continence item within the BI.[45] The DAN-PSS is a 12-question self-reported quality of life questionnaire on the frequency of symptoms and impact (bother) of LUTS. The BI measures disability in performing 10 categories of daily living, including the presence of UI. A total of 421 (43% female) stroke patients were compared with the BI (full or continence item) and DAN-PSS. Both studies identified a significant association between DAN-PSS and BI for the prevalence of UI ($p < 0.01$).[45,50] However, when comparing specifically the presence of incontinence BI score with DAN-PSS, the BI continence item underreported the prevalence of UI. The self-reported prevalence of UI measured by BI was 10.5% and by DAN-PSS was 49%—nearly a five-fold increase.[45] This underreporting was consistent for urge UI (23% reported UI on BI), stress UI (22% reported UI on BI) and other UI (35% reported UI on BI) identified by the DAN-PSS.

3.5.2 | DAN-PSS compared with ICiQ-SF

The ICiQ-SF is a self-reported quality of life questionnaire evaluating the frequency, severity and impact of UI. Fifty patients' (42% female) symptoms were compared with the DAN-PSS and ICiQ-SF. There was a significant positive correlation between ICiQ-SF and both Symptom and Bother scores from the DAN-PSS ($p < 0.01$). The strength of association was higher with the ICiQ-SF than the BI continence score.[50]

3.5.3 | UDS compared with ice water test

UDS are used to diagnose lower urinary tract problems and include cystometry, leak point pressure measurements and pressure flow studies, maximum flow rate and postvoid residual volume measurements. The ice-water test (IWT) is a supplementary urodynamic investigation that cools the bladder wall with ice-cold saline. A positive test is when, following instillation of ice-water, the fluid is expelled from the bladder within 1 min and may indicate patients with upper motor neurone lesion bladder dysfunction. One study compared the IWT on 32 (57% female) stroke patients with overactive detrusor on urodynamics. The threshold volume for involuntary detrusor contraction was significantly lower in the positive IWT group ($p < 0.05$), although the maximum detrusor pressure was higher in the positive than the negative IWT group, this was not statistically significant ($p = 0.61$). The study was unable to conclusively determine that the IWT identifies upper motor neurone lesions in stroke patients.[46]

3.5.4 | UDS compared with CLSS

The CLSS evaluates the severity of 10 LUTS and was compared with UDS in 33 stroke patients (49% female) with severe LUTS.[48] There was no significant difference in CLSS when compared with presence or absence of detrusor sphincter dyssynergia ($p = 0.398$), or when compared with overactive or underactive detrusor ($p = 0.197$). There was a significant negative correlation between maximum flow rate (mean 10,3 ± 5.9; median 9 (2–29) and CLSS ($p = 0.043$ $r = -0.354$), suggesting that the CLSS may indicate LUTS caused by bladder outlet obstruction.[48]

3.5.5 | UDS compared with clinical history and physical examination

UDS results in 38 male stroke patients were compared with pre-UDS clinical history and physical examination.[49] Clinical symptoms were classified into three groups: obstructive (34%), irritative (42%) or mixed (24%). Based on UDS results, 63% were diagnosed with obstruction compared with 34% assessed with obstructive symptoms on clinical history. 82% had detrusor hyperreflexia on UDS and present in 92% of patients with irritative clinical symptoms, 62% with obstructive symptoms and 89% with mixed symptoms. There were no significant differences in pressure flow findings or occurrence of detrusor hyperreflexia when compared with the three clinical symptom groups. Overall, clinical symptoms and physical examination did not predict UDS results.[49]

4 | DISCUSSION

We set out to evaluate the accuracy of different types of UI assessment. A lack of comparator or reference test along with multiple assessment types and different stroke populations restricted synthesis. UI and LUTS after stroke change over time[2–4] and the timing of assessment was highly variable, further limiting synthesis. The

quality of the studies included was generally poor with significant risk of bias in terms of reporting how patients with UI and LUTS were first identified, small samples and reliance on self-reporting of UI or LUTS symptoms. Limitations of this review include restriction of searches to the English language resulting in potential for missing relevant research.

We identified the DAN-PSS; ICiQ-SF and UDS with promising applicability; however, all require further evaluation of their validity and diagnostic accuracy into the poststroke population at different time points after stroke. There is a validated questionnaire to assess LUTS in patients with neurogenic bladder and was not included in this review as it has not been validated in stroke patients.[50] In the UK, the BI is routinely used in stroke services to measure poststroke disability. This review highlights the significant underreporting of UI if the BI is used solely to identify presence of incontinence and we suggest that the continence question on the BI needs to be informed by a more specific assessment, such as the DAN-PSS or ICiQ-SF.

Stroke-specific national clinical guidance focuses on incontinence poststroke with no reference to LUTS.[12,13] This review highlights the burden of LUTS (including UI) prevalent after stroke. Greater than 92% of stroke patients have at least one LUTS before and after 1-month poststroke.[34,38] Despite the high prevalence of LUTS poststroke, assessment of LUTS is surprisingly unaddressed in clinical guidance and research.[12,13]

Poststroke LUTS and UI are complex, interrelated to stroke severity, site of cerebral lesion, cognitive and communication impairment, motor impairment, and mood disturbance.[5,7,16,30,43] Studies did not always report on these important factors and where they are reported, different measures were used. Additionally, our review demonstrates that patients with cognitive and communication impairment are less likely to be recruited due to the self-reporting nature of most assessment methods. Further research is needed to identify accurate assessment methods specifically for this patient group, including the accuracy of carer reporting on behalf of patients.

4.1 | Research recommendations

This review highlights the need for high quality primary research evaluating different diagnostic methods for both poststroke UI and LUTS. There is a need for an agreed gold standard or reference test to evaluate assessment methods. Studies should include diagnostic accuracy in patients with different poststroke impairments, such as cognitive and communication problems, at different timepoints in the trajectory of poststroke recovery in primary and secondary care settings, patient acceptability of different methods and assessment of costs. Improvements on reporting design and results in studies will facilitate future evidence-based clinical care and evidence synthesis.

5 | CONCLUSION

Assessment methods for UI and LUTS after stroke have not been sufficiently evaluated for recommendations in clinical practice and limited due to a lack of an agreed gold standard. To date, clinical guidance has focussed solely on UI with the burden of LUTS largely unacknowledged. More research is needed on screening and diagnosis of LUTS after stroke.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The authors extracted data from original journal publications and are referenced. Data extracted for this review is available in Tables 2–6.

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SUPPORTING INFORMATION

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

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