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CLINICAL ARTICLE

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Sex-specific independent risk factors of urinary incontinence in acute stroke patients: A multicentre registry-based cohort study

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Abstract

Background: The presence of urinary incontinence (UI) in acute stroke patients indicates poor outcomes in men and women. However, there is a paucity and inconsistency of data on UI risk factors in this group and hence we conducted a sex-specific analysis to identify risk factors.

Methods: Data were collected prospectively (2014–2016) from the Sentinel Stroke National Audit Program for patients admitted to four UK hyperacute stroke units. Relevant risk factors for UI were determined by stepwise multivariable logistic regression, presented as odds ratios (OR) and 95% confidence intervals (CI).

Results: The mean (±SD) age of UI onset in men (73.9 year ± 13.1; $n = 1593$) was significantly earlier than for women (79.8 year ± 12.9; $n = 1591$: $p < 0.001$). Older age between 70 and 79 year in men (OR = 1.61: CI = 1.24–2.10) and women (OR = 1.55: CI = 1.12–2.15), or ≥80 year in men (OR = 2.19: CI = 1.71–2.81), and women (OR = 2.07: CI = 1.57–2.74)–reference: <70 year–both predicted UI. In addition, intracranial hemorrhage (reference: acute ischemic stroke) in men (OR = 1.64: CI = 1.22–2.20) and women (OR = 1.75: CI = 1.30–2.34); and prestroke disability (mRS scores ≥ 4) in men (OR = 1.90: CI = 1.02–3.5) and women (OR = 1.62: CI = 1.05–2.49) (reference: mRS scores < 4); and stroke severity at admission: NIHSS scores = 5–15 in men (OR = 1.50: CI = 1.20–1.88) and women (OR = 1.72: CI = 1.37–2.16), and NIHSS scores = 16–42 in men (OR = 4.68: CI = 3.20–6.85) and women (OR = 3.89: CI = 2.82–5.37) (reference: NIHSS scores = 0–4) were also significant. Factors not selected were: a history of congestive heart failure, hypertension, atrial fibrillation, diabetes and previous stroke.

Conclusions: We have identified similar risk factors for UI after stroke in men and women including age >70 year, intracranial hemorrhage, prestroke disability and stroke severity.

KEYWORDS
ageing, co-morbidities, disability, NIHSS

1 | INTRODUCTION

Admissions for acute stroke in England, Wales and Northern Ireland have been rising progressively in the past decade, from about 80 000 during April 2013–March 2014 to about 100 000 during April 2022–March 2023.[1,2] A presentation of urinary incontinence (UI) occurs in 40%–50% of patients during the early phase following an acute stroke,[3–5] compared to a prevalence of 8%–9% in patients before stroke.[3] Defined clinically as any involuntary leakage of urine,[6] UI is a debilitating condition caused by age-related diseases such as bladder or bladder outlet dysfunction,[7] or disruption of micturition neural circuits in conditions such as cerebrovascular stroke.[8] The presence of UI in acute stroke relates closely to greater stroke severity, both of which strongly indicate poor stroke outcomes.[9–12]

Although existing research has been devoted mostly to the impact of UI and outcomes in stroke patients, risk factors of UI in stroke patients are sparsely documented and variably reported in literature. Risk factors include: older age at stroke diagnosis[5,13]; female sex[5]; diabetes[13]; intracranial hemorrhagic stroke[14]; and severity of stroke.[5,13] Conversely, one study showed that hypertension inversely relates to UI.[13] However, the sample sizes of these studies were relatively small and with a limited number of relevant variables.[5,13,14] Associations between risk factors and UI are further complicated by differences in the risk profile for stroke between men and in women, but there exists no sex-specific analysis. In this study, we sought to elucidate the prevalence of stroke-related UI and the risk factors for developing UI by conducting a sex-specific analysis of a broad range of health measures associated with UI in over 3000 men and women presenting with an acute stroke.

2 | METHODS

2.1 | Study design, participants, and setting

In this multicentre registry-based cohort study, as part of the Sentinel Stroke National Audit Program (SSNAP), data were prospectively collected for all patients admitted with an acute stroke in January 2014–February 2016 from four hyperacute stroke units (HASU) in Surrey, south of England.[15]

2.2 | Outcome measures

The presence of UI during hospitalization; age at stroke onset; sex; and a history of co-morbidities were recorded–the latter, including congestive heart failure (CHF), atrial fibrillation (AF), hypertension, diabetes, previous stroke and disability before stroke, were all obtained by questionnaire through history taking from patients and their relatives or carers where necessary, and documented according to the SSNAP protocol.[16] Prestroke disability was assessed by the modified Rankin Scale (mRS), ranging from no disability to severe disability (0–5).[16,17]

2.3 | Diagnosis and severity of acute stroke

Stroke diagnosis was based on clinical presentation with neuroimaging,[15,16] and classified as acute ischemic stroke or intracranial hemorrhage. The severity of stroke symptoms at arrival was assessed by the National Institutes of Health Stroke Scale (NIHSS), with scores ranging between 0 and 42 (no symptoms to severe stroke symptoms).[15,16]

2.4 | Categorization of variables

Age was categorized into three groups: <70, 70–79, and ≥80 years. Patients with an mRS score ≥4 were described as having moderately-severe to severe disability. Those with NIHSS scores of 0–4, 5–15, 16–42 were considered as having "no stroke symptoms or minor stroke", "moderate stroke", "moderate-to-severe stroke or severe stroke" respectively.

2.5 | Statistical analysis

Chi-squared tests were used to explore the relationship between UI and individual risk factors. Independent *t*-tests were used to assess differences between men and women for age. Stepwise multivariable logistic regression was used to assess risk factors for UI (the dependent variable) including: age; co-morbidities (CHF, AF, hypertension, diabetes and previous stroke); pre-stroke disability; intracranial hemorrhage; and stroke severity. All statistical analyses were conducted using SPSS Statistics for Windows, v.28.0 (IBM Corp.) and results were expressed as odds ratios (OR) and 95% confidence intervals (CI).

3 | RESULTS

3.1 | Patient characteristics and stroke outcomes

A total of 1593 men and 1591 women were studied. The mean age of onset in men (73.9 years, SD = 13.1) was significantly earlier than that in women (79.8 years, SD = 12.9; $p < 0.001$). There were 5.9% of patients with a history of CHF, 52.2% with hypertension, 20.1% with AF, 16.2% with diabetes and 23.0% with a history of a previous stroke, whilst 5.6% had a disability (mRS score ≥4) before stroke. Acute ischemic stroke occurred in 83.7% and intracranial hemorrhage in 15.3% (1.0% of patients had an unspecified stroke). At the time of admission, 52.1% of patients had no stroke symptoms or minor symptoms, 33.6% had a moderate stroke, and 14.2% had a moderate-to-severe or a severe stroke. Urinary incontinence affected 49.1% of patients (Table 1). Amongst patients with UI, 95.9% had a documented plan to promote continence during recovery and following discharge

Table 2 shows age-specific rates of UI and individual risk factors of UI in univariable (unadjusted) logistic regressions. Age, intracranial hemorrhage, pre-stroke disability, stroke severity and AF were significantly associated with UI in both sexes, and hypertension and a previous stroke were associated with UI in men only.

Stepwise multivariable logistic regression analyses (Table 3) showed that age significantly predicted UI: age 70–79 year in men (OR = 1.61: CI = 1.24–2.10) and women (OR = 1.55: CI = 1.12–2.15); age ≥80 yr in men (OR = 2.19: CI = 1.71–2.81) and women (OR = 2.07; CI = 1.57–2.74) (with reference to the <70 year group).

TABLE 1 Distribution of 3184 acute stroke patients admitted to hyperacute stroke units in Surrey between January 2014 and February 2016.

	n	%
Sex		
Men: women	1593: 1591	50.0: 50.0
Medical history		
Congestive heart failure	188	5.9
Atrial fibrillation	645	20.3
Previous stroke	733	23.0
Hypertension	1662	52.2
Diabetes	515	16.2
Types of stroke		
Ischemic stroke: intracranial hemorrhage: unspecified stroke	2664: 488: 32	83.7: 15.3: 1.0
Prestroke disability (mRS scores ≥ 4)	177	5.6
Severity of stroke		
No stroke symptoms to minor symptoms (NIHSS scores = 0–4)	1660	52.1
Moderate stroke (NIHSS scores = 5–15)	1070	33.6
Moderately-severe to severe stroke (NIHSS scores = 16–42)	454	14.2
Urinary incontinence	1564	49.1

Abbreviations: mRS, modified Rankin Scale; NIHSS, National Institutes of Health Stroke Scale.

In addition several co-morbidities and conditions also predicted UI and included: intracranial hemorrhage in men (OR = 1.64: CI = 1.22–2.20) and women (OR = 1.75: CI = 1.30–2.34) (reference: acute ischemic stroke); pre-stroke disability, with MRS scores ≥4, in men (OR = 1.90: CI = 1.02–3.56) and women (OR = 1.62: CI = 1.05–2.49) (reference: mRS scores < 4); and increasing stroke severity at admission, with NIHSS scores = 5–15, in men (OR = 1.50: CI = 1.20–1.88) and women (OR = 1.72: CI = 1.37–2.16); and with NIHSS scores = 16–42 in men (OR = 4.68: CI = 3.20–6.85) and women (OR = 3.89: CI = 2.82–5.37) (both referenced to: NIHSS scores = 0–4). Factors not selected by this stepwise regression model included: a history of CHF, hypertension, AF, diabetes and previous stroke. Similar patterns to the above results were observed for the association between risk factors and UI when both sexes were analysed together (Figure 1).

TABLE 2 Sex-specific univariable logistic regression to predict UI in men and women with acute stroke.

	Risk for having UI in acute stroke							
	Men ($n = 1593$)				Women ($n = 1591$)			
	Event rate (%)	OR	95% CI	p	Event rate (%)	OR	95% CI	p
<70 years (reference)	34.4	1	—	—	36.7	1	—	—
70-80 years	46.4***	1.65	1.28–2.13	<0.001	49.1***	1.66	1.22–2.28	0.001
≥80 years	55.4***	2.37	1.87–3.01	<0.001	59.0***	2.48	1.90–3.24	<0.001
Acute ischemic stroke (reference)	43.6	1	—	—	50.7	1	—	—
Intracranial hemorrhage	59.8***	1.92	1.46–2.54	<0.001	64.4***	1.76	1.33–2.33	<0.001
Prestroke mRS scores <4 (reference)	44.9	1	—	—	51.0	1	—	—
Prestroke mRS scores ≥4	66.7***	2.45	1.38–4.36	0.002	71.5***	2.41	1.61–3.62	<0.001
NIHSS scores 0-4 (reference)	37.4	1	—	—	41.3	1	—	—
NIHSS scores 5-15	49.2***	1.62	1.30–2.02	<0.001	56.5***	1.85	1.48–2.31	<0.001
NIHSS scores 16-42	76.1***	5.33	3.69–7.71	<0.001	76.3***	4.56	3.34–6.24	<0.001
No history of congestive heart failure (reference)	45.0	1	—	—	52.0	1	—	—
History of congestive heart failure	55.7*	1.51	0.99–2.29	0.053	62.0*	1.53	0.99–2.36	0.053
No history of hypertension (reference)	43.1	1	—	—	50.6	1	—	—
History of hypertension	48.3*	1.23	1.01–1.50	0.039	54.3^{NS}	1.16	0.95–1.41	0.143
No history of atrial fibrillation (reference)	43.4	1	—	—	50.9	1	—	—
History of atrial fibrillation	55.8***	1.65	1.28–2.13	<0.001	58.6**	1.37	1.08–1.74	0.010
No history of diabetes (reference)	45.0	1	—	—	52.4	1	—	—
History of diabetes	48.5^{NS}	1.15	0.89–1.49	0.293	53.9^{NS}	1.06	0.81–1.40	0.659
No history of previous stroke (reference)	43.8	1	—	—	51.5	1	—	—
History of previous stroke	52.0**	1.39	1.09–1.76	0.007	56.2^{NS}	1.21	0.96–1.52	0.111

Abbreviations: mRS, modified Rankin Scale; NIHSS, National Institutes of Health Stroke Scale; NS, not significant.

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

4 | DISCUSSION

4.1 | Key findings

In this study of a large number of patients presenting with an acute stroke, we have shown that men and women have similar independent risk factors for UI. Intracranial hemorrhage, prestroke disability, older age and greater stroke severity were associated with a higher prevalence of UI. This information helps identify patients with an acute stroke who are at increased risk of developing UI.

The findings of an association between age, stroke severity and intracranial hemorrhage with UI in this study are consistent with those reported from previous studies.[5,13,14] The association between disability/frailty and UI has been demonstrated previously in non-stroke individuals.[18–20] Our study of stroke patients, which is less well-reported, strengthened this finding. Pre-stroke disability is an important indicator of underlying health status of the patient and relates to poor stroke outcomes such as prolonged length of stay on HASU, nosocomial infections, in-hospital mortality and a greater need for higher levels of care on discharge.[21] This study also

TABLE 3 Sex-specific stepwise multivariable logistic regression analysis for the association between risk factors and UI in men and women with acute stroke.

Factors selected by stepwise regression	Risk for having UI in acute stroke					
	Men ($n = 1593$)			Women ($n = 1591$)		
	OR	95% CI	p	OR	95% CI	p
<70 years (reference)	1	—	—	1	—	—
70–80 years	1.61	1.24–2.10	<0.001	1.55	1.12–2.15	0.008
≥80 years	2.19	1.71–2.81	<0.001	2.07	1.57–2.74	<0.001
Acute ischemic stroke (reference)	1	—	—	1	—	—
Intracranial hemorrhage	1.64	1.22–2.20	<0.001	1.75	1.30–2.34	<0.001
Prestroke mRS scores <4 (reference)	1	—	—	1	—	—
Prestroke mRS scores ≥4	1.90	1.02–3.56	0.044	1.62	1.05–2.49	0.028
NIHSS scores 0–4 (reference)	1	—	—	1	—	—
NIHSS scores 5–15	1.50	1.20–1.88	<0.001	1.72	1.37–2.16	<0.001
NIHSS scores 16–42	4.68	3.20–6.85	<0.001	3.89	2.82–5.37	<0.001
Factors not selected by stepwise regression						
History of congestive heart failure	—	—	—	—	—	—
History of hypertension	—	—	—	—	—	—
History of atrial fibrillation	—	—	—	—	—	—
History of diabetes	—	—	—	—	—	—
History of previous stroke	—	—	—	—	—	—

Abbreviations: mRS, modified Rankin Scale; NIHSS, National Institutes of Health Stroke Scale.

found that several factors including female sex, CHF, hypertension and AF only associated with UI on univariate analyses, but this association disappeared in stepwise multivariable regression analysis. We found diabetes did not associate with UI even in a univariable analysis, which is consistent with most studies except one, which reported an association.[13]

We recognize that overadjustment may introduce certain biases[22] in reporting the association between risk factors and UI since many variables of interest tend to relate closely to each other, for example, pre-existing morbidities tend to associate with older age as well as severe stroke, whilst age and stroke severity are closely related to UI. Thus, pre-existing morbidities eliminated from stepwise multivariable analysis do not necessarily imply that they are not a risk factor of UI, that is, severe stroke and older age are probably acting as proxies for underlying morbidities, or possibly because they are surrogates for pre-stroke disability or some other factors, thus masking the association between morbidities and UI when age and stroke severity are included in a multivariable regression model. The association of age and prestroke disability with other risk factors that are related to UI in univariable analysis (unadjusted) such as AF, hypertension and previous stroke is likely to be complex. With older age, these factors are more prevalent, which lead to greater disability. Unraveling these individual risk factors remains a challenge since older individuals often have multiple morbidities.

Although diabetes was not a risk factor for UI in the present study, which is in contrast with findings from some other studies of stroke patients.[13] This may be due to a discrepancy in patient populations where severity or control of diabetes may be different. Studies of non-stroke female patients yielded conflicting findings, with some reported an increased risk of UI with poorer glycaemic control, as reflected by higher levels of glycated hemoglobin (HbA1c),[23,24] whilst others found no association.[25,26]

There exists a paucity of analysis on sex-specific risk factors for UI, our findings are therefore novel and revealed similar (although not identical) ORs for men and women in multivariable regression model. Furthermore, we repeated the analysis on both sexes together and demonstrated that the sex factor does not contribute significantly to the risk of UI in acute stroke. These

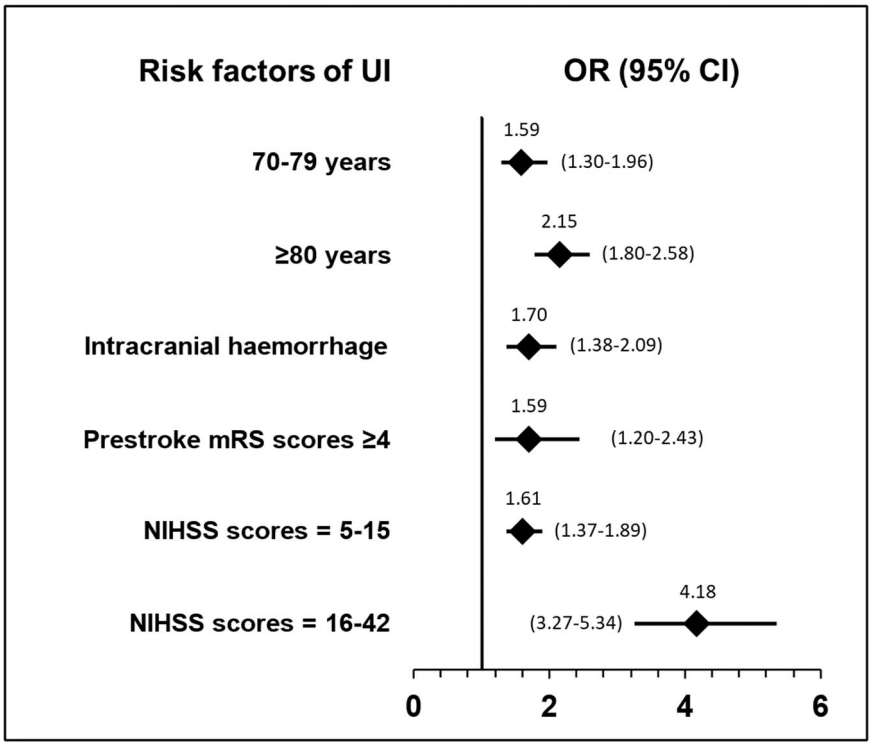

FIGURE 1 Stepwise multivariable logistic regression analysis to assess predictors of UIs in both sexes. Only significant factors are presented. Variables included in the multivariable model that did not achieve a significance level (<0.05) included: sex, history of CHF, hypertension, AF, diabetes and previous stroke. Reference groups for respective risk factors are shown Table 3.

findings therefore provide important information for future research in this area when designing studies that include both sexes.

An incidence of 49% for UI amongst acute stroke patients in our study is consistent with previously reported figures.[3–5] Furthermore, UI continued to persist amongst a quarter and a third of stroke patients twelve months after the event,[5,12] and UI remained a major risk factor associated with disability and death up to 2 years after of an acute stroke.[11] UI is also detrimental to a patient's quality of life, limiting their activities of daily living and mental health[27,28] It also places great burdens to caregivers and family members[29] and increased healthcare costs.[28] Therefore, plans that promote continence are important to this group of patients.[30] Continence management plans for 95.9% of applicable patients were drawn up by discharge in the centers included in this study, which is higher than national figures for patients admitted with an acute stroke reported by SSNAP of 92.8% in 2016, and 94.4% in 2017.[16]

4.2 | Limitations

Certain limitations to this study arise from its cross-sectional design. Caution should be taken when interpreting our results since the study focussed only on stroke patients. This study, guided by the national audit protocol (SSNAP), is limited by the absence of information on the types of UI and patients with UI before stroke, which may have different risk factors profiles. It is possible that our study may contain higher proportions of patients with UI before stroke, particularly those a previous stroke as UI has been known to persist up to 2 years after an acute stroke in certain individuals.[11] The strengths of our study lie in a sizeable cohort of patients admitted consecutively from one of the largest NHS regions in the UK. The data consist of a wide range of relevant variables with similar clinical characteristics to those from reported from the UK national audit.[16] The present study did not include information on patients with UI before stroke. Studies from SSNAP showed the majority of UI occurred as a consequence of stroke whilst 8%–9% of patients had UI before their stroke.[3] Nevertheless, pre-existing UI tend to worsen after acute stroke.[31]

In conclusion, men and women have similar risk factors for UI including older age, intracranial hemorrhage, prestroke disability and stroke severity. This information helps identify patients with an acute stroke who are at increased risk of UI.

AUTHOR CONTRIBUTIONS

Thang S. Han and David Fluck reviewed the topic related literature and Thang S. Han performed the study concept and analysis design. Brendan Affley and Puneet Kakar performed the study coordination and data collection.

Thang S. Han wrote the first draft, analysed, interpreted the data and revised the manuscript. Christopher H. Fry and Pankaj Sharma edited the manuscript. Adam Fluck, David Fluck, Brendan Affley, Puneet Kakar and Pankaj Sharma checked, interpreted the results and commented on the manuscript. All authors approved the final version.

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CONFLICT OF INTEREST STATEMENT

No conflicts of interest.

DATA AVAILABILITY STATEMENT

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

ETHICS STATEMENT

The SSNAP has approval from the Confidentiality Advisory Group of the Health Research Authority to collect patient data under section 251 of the National Health Service Act 2006. This study was conducted in accordance with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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