BJU Int 2024; 133: 604–613 doi:10.1111/bju.16320

BJUI
BJU International

Original Article

Urinary incontinence indicates mortality, disability, and infections in hospitalised stroke patients

Christopher H. Fry[1], Adam Fluck[2], Brendan Affley[3], Puneet Kakar[6], Pankaj Sharma[7,8], David Fluck[4] and Thang S. Han[7,5]

[1]School of Physiology, Pharmacology and Neuroscience, University of Bristol, Bristol, [2]Faculty of Medical Sciences, The Medical School, Newcastle University, Newcastle upon Tyne, [3]Department of Stroke, [4]Department of Cardiology, [5]Department of Endocrinology, Ashford and St Peter's NHS Foundation Trust, Chertsey, [6]Department of Stroke, Epsom and St Helier University Hospitals, Epsom, [7]Institute of Cardiovascular Research, Royal Holloway University of London, Egham, and [8]Department of Clinical Neuroscience, Imperial College Healthcare NHS Trust, London, UK

Objectives

To assess the impact of urinary incontinence (UI) on health outcomes over the entire spectrum of acute stroke severity (National Institutes of Health Stroke Scale [NIHSS] scores: 0–42), due to a paucity of data on patients with milder strokes.

Patients and Methods

Data were prospectively collected (2014–2016) from the Sentinel Stroke National Audit Programme (1593 men, 1591 women; mean [SD] age 76.8 [13.3] years) admitted to four UK hyperacute stroke units (HASUs). Relationships between variables were assessed by multivariable logistic regression. Data were adjusted for age, sex, comorbidities, pre-stroke disability and intra-cranial haemorrhage, and presented as odds ratios with 95% confidence intervals.

Results

Amongst patients with no symptoms or a minor stroke (NIHSS scores of 0–4), compared to patients without UI, patients with UI had significantly greater risks of poor outcomes including: in-hospital mortality; disability at discharge; in-hospital pneumonia; urinary tract infection within 7 days of admission; prolonged length of stay on the HASU; palliative care by discharge; activity of daily living (ADL) support, and new discharge to care home. In patients with more moderate stroke (NIHSS score of 5–15) the same outcomes were identified; being at greater risk for patients with UI, except for palliative care by discharge and ADL support. With the highest stroke severity group (NIHSS score of 16–48) all outcomes were identified except in-patient mortality, pneumonia, and ADL support. However, odds ratios diminished as NIHSS scores increased.

Conclusions

Urinary incontinence is a useful indicator of poor short-term outcomes in older patients with an acute stroke, but irrespective of stroke severity. This provides valuable information to healthcare professionals to identify at-risk individuals.

Keywords

Disability, mortality, healthcare associated infections, hospital length of stay, healthcare burden

Introduction

Urine storage and voiding by the lower urinary tract in humans is controlled by a complex network of neural circuits in the brain and spinal cord [1,2]. Disruption of these circuits with diseases, such as stroke, can be associated with urinary incontinence (UI); defined clinically as any involuntary leakage of urine [3]. It is thought that UI amongst patients with stroke is due to suprapontine lesions, which result in loss of voluntary inhibition of voiding [4]. However, the occurrence of UI is not limited to damage of a specific area of the brain, e.g., pre-frontal cortex, but relates to the extent (size) of cerebral lesions [5]. There are several types of UI arising from various pathophysiological mechanisms. Stress, urge, overflow or mixed UI are common, whilst reflex and functional UI, as well as nocturnal enuresis is also possible. [4,6]. Data from the Sentinel Stroke National Audit Programme (SSNAP) in the UK between 1998 and 2004 showed UI was present within

BJU International published by John Wiley & Sons Ltd on behalf of BJU International. www.bjui.org

1 week after an acute stroke (early phase) in 30–44% of patients, which reduced to 15–20% at discharge. There were also 8–9% of patients with pre-stroke UI [7]. Similar studies from Germany and Australia have shown higher rates (53%) of UI occurring in this early post-stroke phase [8] and 12 months later (32–38%) [8,9].

Although stroke severity, commonly assessed by the National Institutes of Health Stroke Scale (NIHSS), is an established indicator of poor outcomes [10], UI in patients with acute stroke also relates to several adverse outcomes including mortality [11] and disability [12], such that the incidence of UI has been suggested as a marker of stroke severity [13,14]. However, the role of UI on the impact of stroke outcomes is likely to be more complex and remains poorly understood [13]. Previous research has been hampered by small sample sizes and few outcome measures [8,9,12,15], and also by a paucity of knowledge about the independent role of UI on outcomes (irrespective of stroke severity and other confounding factors), particularly amongst patients with either no stroke symptoms or only a minor stroke (NHISS scores of 0–4). To address this discrepancy, we conducted a relatively large study on >3000 patients with stroke. The aim was to examine the impact of UI on outcome measures, including in-hospital mortality, early infections and malnutrition, and disability and care support at discharge, over the entire spectrum of acute stroke severity (NIHSS scores from 0 to 42).

Patients and Methods

Study Design, Participants and Setting

Through our participation in the SSNAP [16], data were prospectively collected for all patients admitted with an acute stroke to four hyperacute stroke units (HASUs) in Surrey, south England, between January 2014 and February 2016 [17]. Age at stroke onset; sex; and a history of congestive heart failure (CHF), atrial fibrillation (AF), hypertension, diabetes mellitus (DM); as well as a previous stroke were all documented [16,17].

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.

Stroke Diagnosis and Outcome Measures

Stroke was diagnosed on the basis of clinical presentation and neuroimaging [16,17], and classified as acute ischaemic stroke or intracranial haemorrhage (ICH). The severity of stroke symptoms at arrival was assessed by the NIHSS, ranging from minimum to maximum NIHSS scores of 0–42 (no symptoms to severe stroke symptoms) [16,17].

Urinary incontinence, based on clinical evidence of involuntary urinary leakage [3], was documented at the time of admission. Pneumonia was defined as those patients who received treatment with antibiotics for a newly-acquired condition. Investigation of a UTI was carried out by obtaining a mid-stream urine sample, or a fresh sample from a urinary catheter using an aseptic technique (residual urine was discarded from the tubing before sample collection from the catheter sampling port) and sent for culture. Diagnosis of a UTI was confirmed by a positive urine culture where bacteria or yeast were present. Pneumonia and UTI were both diagnosed in the first 7 days following the initial admission for stroke [16,17]. Patients who were at high risk of malnutrition were identified by the Malnutrition Universal Screening Tool (MUST) protocol [18,19]. Length of stay (LOS) was calculated from the duration between the dates of arrival to the HASU and discharge from the HASU to any destination, including patients' own homes, rehabilitation units, or care homes.

Pre- and post-stroke disability at the time of discharge were assessed by the modified Rankin Scale (mRS), ranging from no disability to severe disability (score 0–5). The level of care that was planned for patients on discharge included support for activity of daily living (ADL) and care-home placements [16,17]. Palliative care at discharge and mortality were also documented [16]. Patients with UI were assessed by specialist nurses who shared a management plan with the patient to promote continence tailored to their individual needs. The continence plan comprised lifestyle interventions (adequate fluid intake and avoidance of caffeine-containing drinks), bladder training, pelvic floor exercises, physical therapies (e.g., electrical stimulation) and medications (e.g., muscarinic receptor antagonists, such as oxybutynin, or β_3-adrenoceptor agonists, such as mirabegron) where appropriate [20].

Categorisation of Variables

Patients with a mRS score of ≥4 were described as having moderately severe or severe disability. Those with NIHSS scores of 0, 1–4, 5–15, 16–20, and 21–42 were considered as having 'no stroke symptoms', 'minor stroke', 'moderate stroke', 'moderate-to-severe stroke', and 'severe stroke', respectively. A prolonged LOS was defined as >14 days on the HASU.

Statistical Analysis

Statistical analyses were conducted using the Statistical Package for the Social Sciences (SPSS®) for Windows, version 28.0 (IBM Corp., Armonk, NY, USA). To explore the impact of UI on patient outcomes with milder stroke severities, we conducted a multivariable logistic regression (MLR) analysis and stratification technique by partitioning stroke severity into three categories according to severity level: no stroke symptoms or minor stroke (NIHSS scores of 0–4); moderate stroke (NIHSS scores of 5–15); moderate-to-severe or severe stroke (NIHSS scores of 16–42). In the MLR approach, UI (patients without UI as a reference) was used to predict outcome measures including: in-patient mortality; disability at discharge; pneumonia; UTI; risk of malnutrition; prolonged LOS on the HASU; palliative care decision by discharge; ADL support; and discharge to care home. Data were adjusted for confounding factors (age; sex; comorbidities; ICH; and pre-stroke disability). To enhance the model performance, the interaction effects of UI and stroke severity on outcome measures were also examined by incorporating the interaction term UI × stroke severity (continuous variable: NIHSS scores of 0–42) in MLR model. Included results are expressed as odds ratios (ORs) and 95% CIs. Data are presented to two significant figures for percentages and two decimal places for ORs.

Results

Patient Characteristics

Data from 3184 patients (1593 men and 1591 women), with a mean (SD) age of 76.8 (13.3) years, were analysed. There were 5.9% with a history of CHF, 20% with AF, 23% with a previous stroke, 52% with hypertension, 16% with DM, whilst pre-stroke disability (mRS score of ≥4) was present in 5.6%.

An acute ischaemic stroke occurred in 84% and ICH in 15% of patients; 1.0% had an unspecified stroke diagnosis. At the time of admission, 13% and 39% of patients had no stroke symptoms or minor symptoms, respectively, 34% had a moderate stroke, and 7.3% and 6.9% had a moderate-to-severe and severe stroke, respectively. UI affected 49% of patients. Amongst patients with UI, 96% had a documented plan to promote continence. During admission, 15% of patients died, 11% and 7.6% acquired pneumonia and UTI, respectively. There were 28% of patients who has a LOS on the HASUs of >14 days. By discharge, 31% of patients had disabilities, 27% were at risk of malnutrition, and 6.1% had a decision made for palliative care. Support for ADL and a new care home on discharge were required by 17% and 5.6% of patients, respectively (Table 1).

Stroke Outcomes

Overall, 5.1% of patients died without UI, whilst 25% died with UI (chi-squared = 258, $P < 0.001$). The rates and number of patients with UI increased progressively with the severity of stroke, with 25% (106/424) and 44% (545/1236) in those with no symptoms or a minor stroke, rising to 53% (567/1070) in those with a moderate stroke, and further to 74% (174/234) and 78% (172/220) amongst those with a moderate-to-severe and severe stroke, respectively (Fig. 1A).

Table 1 Distribution of 3184 patients with acute stroke admitted to HASUs in Surrey between January 2014 and February 2016.

Variable	*N* (%)
Sex	
Men: women	1593: 1591 (50: 50)
Medical history	
History of CHF	188 (5.9)
History of AF	645 (20)
History of previous stroke	733 (23)
History of hypertension	1662 (52)
History of DM	515 (16)
History of pre-stroke disability (mRS score ≥4)	177 (5.6)
Types of stroke	
Ischaemic stroke: ICH: unspecified stroke	2664: 488: 32 (84: 15: 1.0)
Severity of stroke	
No stroke symptoms (NIHSS score = 0)	424 (13)
Minor stroke (NIHSS score = 1–4)	1236 (39)
Moderate stroke (NIHSS score = 5–15)	1070 (34)
Moderate-to-severe stroke (NIHSS score = 16–20)	234 (7.3)
Severe stroke (NIHSS score = 21–42)	220 (6.9)
UI	1564 (49)
Outcome measures	
In-patient mortality	480 (15)
Disability by discharge (mRS score ≥4)	989 (31)
Pneumonia	358 (11)
UTI	243 (7.6)
Risk of malnutrition	853 (29)
LOS on HASU >14 days	892 (28)
Palliative care by discharge	193 (6.1)
ADL support	544 (17)
New discharge to care home	177 (5.6)

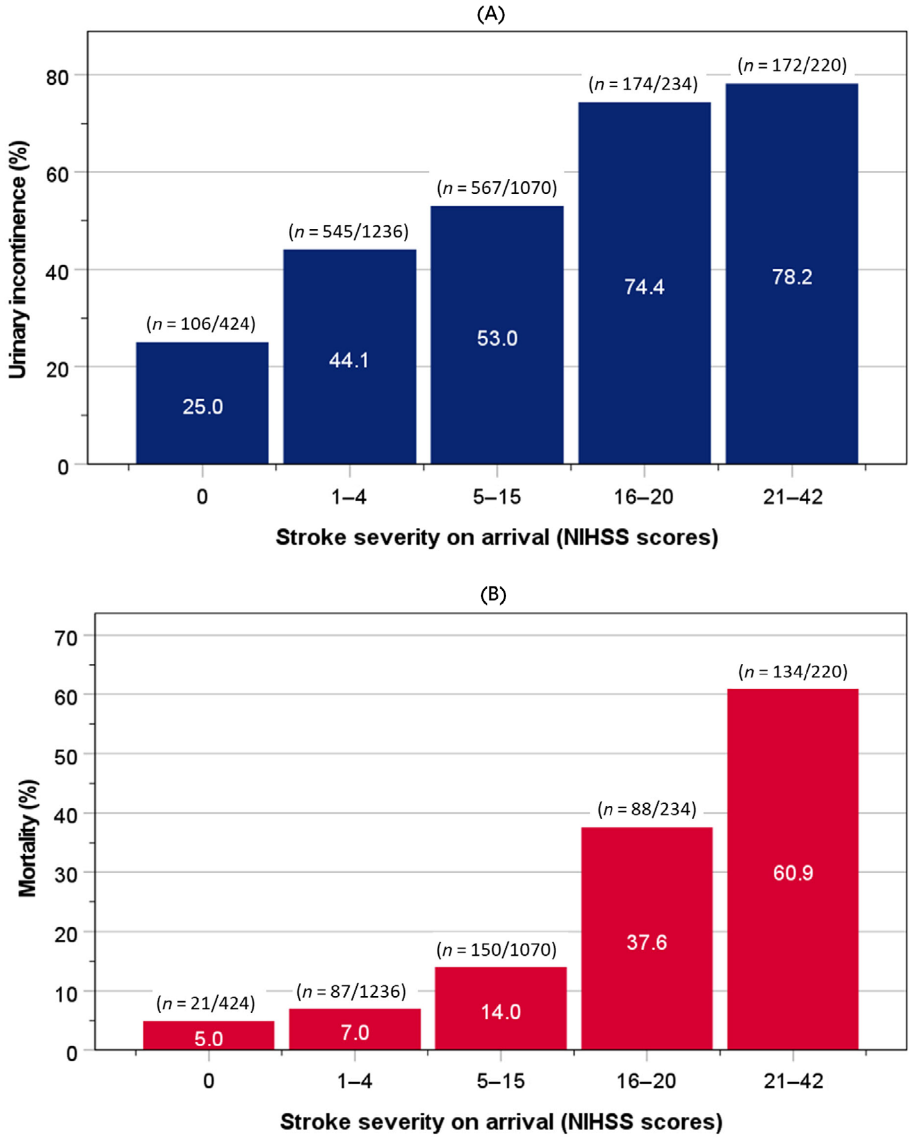
This was mirrored by the increasing rates of in-patient mortality with corresponding figures of 5% (21/424), 7% (87/1236), 14% (150/1070), 38% (88/234), and 61% (134/22) (Fig. 1B).

Representative plots of outcomes showed that within every category of stroke severity, the rates of mortality (Fig. 2A), disability at discharge (Fig. 2B) and prolonged LOS on the HASU (Fig. 2C) were higher in patients with UI than those without UI. These patterns were also demonstrated for other outcomes including malnutrition, ADL support (except for the moderate–severe stroke group) and new discharge to a care home, as well as pneumonia (except the most severe stroke group). However, the rates of UTI and palliative care were higher in those with UI only amongst the less severe stroke groups (NIHSS score of 0–15; Fig. S1A–F).

Outcome Measures According to Severity of Stroke

Table 2 shows outcome measures expressed in absolute numbers and percentage rates ($[n/N] \times 100$) according to the three groups of stroke severity: NIHSS scores of 0–4 (no symptoms or minor stroke), 5–15 (moderate stroke), and 16–42 (moderate-to-severe or severe stroke). Poor outcome

Fig. 1 Percentage rates of UI **(A)** and mortality **(B)** amongst patients who presented with different severities of acute stroke.

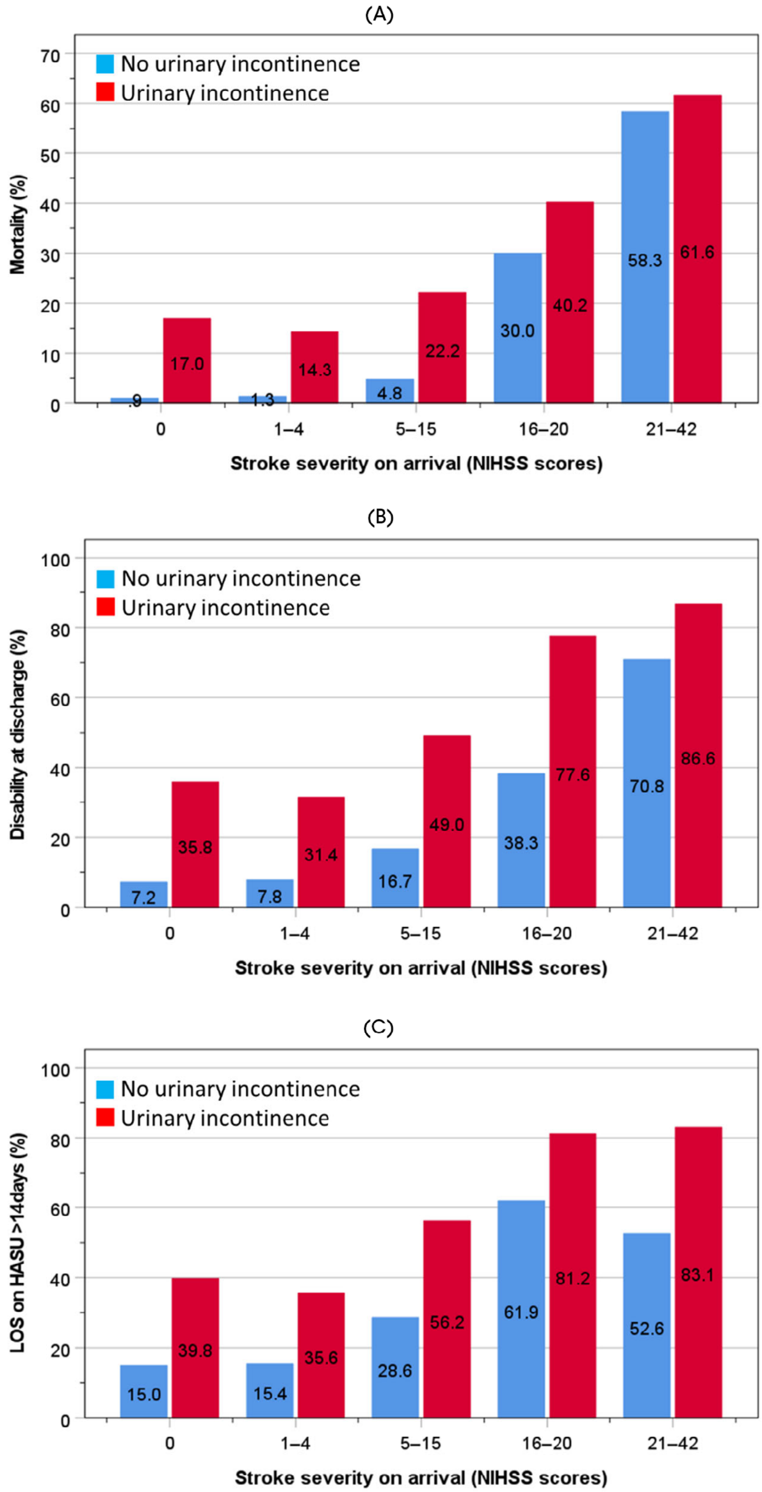


measures increased progressively with severity of stroke and were more prevalent amongst patients with UI compared to those without UI for every level of stroke severity (except for UTI and palliative care in those with severe stroke where the prevalences were lower in those with UI).

Patients with either UI or more severe stroke were at greater risk of poor health outcomes (except for the lack of association between stroke severity and new discharge to a care home). There was an interaction between UI and stroke severity on outcomes including: mortality, pneumonia and UTI, a need for palliative care and ADL support by discharge, whilst this interaction term was not significant in MLR models for disability, risk of malnutrition, LOS on the HASU or discharge to a care home (Table 3).

Table 4 shows that amongst patients with no symptoms or minor stroke (NIHSS scores of 0–4), compared to patients without UI, those with UI had greater risk of poor outcomes including mortality: event rates = 15% vs 1.2%, OR = 13.65 (95% CI 6.78–27.49); disability at discharge: event rates = 32% vs 7.6%, OR = 4.75 (95% CI 3.47–6.51); pneumonia: event rates = 6.8% vs 2.1%, OR = 3.54 (95% CI 1.98–6.34); UTI developed within 7 days of admission: event rates = 7.1% vs 1.8%, OR = 3.51 (95% CI 1.92–6.41); high risk of malnutrition: event rates = 25% vs 8.2%, OR = 3.17 (95% CI 2.35–4.27); prolonged LOS (>14 days) on the HASU: event rates = 36% vs 15%, OR = 2.72 (95% CI 2.10–3.53); palliative care: event rates = 5.1% vs 0.6%, OR = 6.79 (95% CI 2.55–18.06); ADL support: event rates = 22% vs 11%, OR = 1.86 (95% CI 1.38–2.50); and new discharge to a care

Fig. 2 Percentage rates of mortality **(A)** disability by discharge **(B)** and prolonged LOS on HASUs **(C)** amongst patients who presented with different severities of acute stroke, with or without UI.



home: event rates = 5.7% vs 1.9%, OR = 2.30 (95% CI 1.27–4.16). Amongst patients with moderate stroke (NIHSS scores of 5–15), compared to patients without UI, those with UI also had significantly greater risk of mortality: event rates = 22% vs 4.8%, OR = 4.91 (95% CI 3.04–7.93); disability at discharge: event rates = 49% vs 16.7%, OR = 4.79 (95% CI

Table 2 The presence of outcome measures expressed in absolute numbers and rates [$(n/N) \times 100$] according to severity of stroke.

	No symptoms to minor stroke (NIHSS scores = 0–4)		Moderate stroke (NIHSS scores = 5–15)		Moderate-to-severe stroke or severe stroke (NIHSS scores = 16–42)	
	UI (*N* = 651) *n* (%)	No UI (*N* = 1009) *n* (%)	UI (*N* = 567) *n* (%)	No UI (*N* = 505) *n* (%)	UI (*N* = 346) *n* (%)	No UI (*N* = 108) *n* (%)
In-patient mortality	96 (15)	12 (1.2)	126 (22)	24 (4.8)	176 (51)	46 (43)
Disability by discharge (mRS score ≥4)	209 (32)	77 (7.6)	278 (49)	84 (17)	284 (82)	57 (53)
Pneumonia	44 (6.8)	21 (2.1)	116 (21)	27 (5.4)	115 (34)	35 (32)
UTI	46 (7.1)	18 (1.8)	79 (14)	27 (5.4)	43 (12)	30 (28)
Risk of malnutrition	160 (25)	82 (8.2)	235 (42)	100 (20)	233 (70)	43 (40)
LOS on HASU >14 days	194 (36)	147 (15)	245 (56)	134 (29)	136 (82)	36 (59)
Palliative care by discharge	33 (5.1)	6 (0.6)	31 (5.5)	16 (3.2)	72 (21)	35 (32)
ADL support	124 (23)	112 (11)	131 (30)	119 (25)	43 (26)	15 (24)
New discharge to care home	37 (5.7)	19 (1.9)	61 (11)	19 (3.8)	38 (11)	3 (2.8)

Table 3 Multivariable logistic regression analysis to assess the impact of UI and stroke severity on adverse outcomes amongst patients who presented with an acute stroke.

Outcome	UI* OR (95% CI)	Stroke severity*,† OR (95% CI)	UI × stroke severity interaction *P*
In-patient mortality	15.08 (8.45–26.89)	1.23 (1.19–1.28)	<0.001
Disability by discharge (mRS score ≥4)	4.35 (3.18–5.95)	1.12 (1.10–1.15)	0.629
Pneumonia	5.39 (3.32–8.76)	1.16 (1.12–1.20)	<0.001
UTI	5.47 (3.30–9.07)	1.15 (1.11–1.18)	<0.001
Risk of malnutrition	2.97 (2.25–3.92)	1.09 (1.07–1.12)	0.977
LOS on HASU >14 days	2.53 (1.93–3.33)	1.11 (1.08–1.14)	0.281
Palliative care by discharge	6.79 (2.55–18.06)	5.65 (2.66–12.03)	<0.001
ADL support	1.84 (1.38–2.47)	1.06 (1.04–1.09)	0.005
New discharge to care home	2.79 (1.65–4.73)	1.02 (0.98–1.07)	0.844

**The variables UI, stroke severity and interaction term (UI × stroke severity) were all analysed simultaneously with adjustment for comorbidities including: CHF, AF, hypertension, DM, previous stroke, ICH, and disability before stroke. †Stroke severity was used as continuous variable (NIHSS scores: 0–42).*

Table 4 Multivariable logistic regression analysis to assess the impact of urinary incontinence on adverse outcomes amongst patients presented with an acute stroke, stratified by stroke severity.

Outcome	Risk amongst patient with UI (no UI as reference) adjusted for age, sex, and comorbidities*		
	No symptoms to minor stroke (NIHSS scores = 0–4) OR (95% CI)	Moderate stroke (NIHSS scores = 5–15) OR (95% CI)	Moderate-to-severe stroke or severe stroke (NIHSS scores = 16–42) OR (95% CI)
In-patient mortality	13.65 (6.78–27.49)	4.91 (3.04–7.93)	1.54 (0.96–2.47)
Disability by discharge (mRS score ≥4)	4.75 (3.47–6.51)	4.79 (3.47–6.62)	5.69 (3.31–9.79)
Pneumonia	3.54 (1.98–6.34)	3.85 (2.45–6.03)	1.21 (0.74–1.98)
UTI	3.51 (1.92–6.41)	2.44 (1.52–3.90)	0.39 (0.22–0.68)
Risk of malnutrition	3.17 (2.35–4.27)	2.64 (1.98–3.52)	3.77 (2.35–6.04)
LOS on HASU >14 days	2.72 (2.10–3.53)	3.14 (2.36–4.18)	3.67 (1.82–7.44)
Palliative care by discharge	6.79 (2.55–18.06)	1.36 (0.71–2.61)	0.52 (0.31–0.86)
ADL support	1.86 (1.38–2.50)	1.05 (0.77–1.44)	1.18 (0.57–2.45)
New discharge to care home	2.30 (1.27–4.16)	2.57 (1.49–4.42)	4.20 (1.25–14.06)

**Comorbidities: CHF, AF, hypertension, DM, previous stroke, ICH, and disability before stroke.*

3.47–6.62); pneumonia: event rates = 21% vs 5.4%, OR = 3.85 (95% CI 2.45–6.03); UTI developed within 7 days of admission: event rates = 14% vs 5.4%, OR = 2.44 (95% CI 1.52–3.90); high risk of malnutrition: event rates = 42% vs 20%, OR = 2.64 (95% CI 1.98–3.52); prolonged LOS (>14 days) on the HASU: event rates = 56% vs 29%, OR = 3.14 (95% CI 2.36–4.18); and new discharge to a care home: event rates = 11% vs 3.8%, OR = 2.57 (95% CI 1.49–

4.42); but the UI and non-UI groups did not differ significantly for the need of palliative care: event rates = 5.5% vs 3.2%, OR = 1.36 (95% CI 0.71–2.61); and ADL support: event rates = 30% vs 25%, OR = 1.05 (95% CI 0.77–1.44). Amongst patients with severe stroke (NIHSS scores of 16–42), UI continued to be a risk factor of poor outcomes, except for mortality, infections, ADL support, and palliative care where the size of ORs diminished.

Discussion

Summary of Main Findings

In this study of a relatively large number of patients presenting with an acute stroke, we show that UI was an independent risk factor for many poor healthcare outcomes. This was apparent across the spectrum of stroke severity and included patients with no symptoms or minor stroke symptoms (NIHSS scores of 0–4) and who comprised over half of all the patients with stroke. Furthermore, there was an interaction between UI and stroke severity on a number of health outcomes. To the best of our knowledge, these findings have not been documented elsewhere.

Risk Factors Associated with UI

We found a range of factors associated with UI including older age, female sex, previous stroke, comorbidities such as CHF, AF, and hypertension (but not DM), ICH, as well as pre-stroke disability (Table S1). Little information is available in the current literature regarding such risk factors for UI. Nevertheless, our findings are broadly in line with those from previous studies [21,22].

Risk of Post-Stroke Mortality and Disability

Previous studies have shown that UI in acute stroke is a risk factor for post-stroke outcomes [11,12], and are consistent with our findings. Although UI was comparable to stroke severity in the prediction of poor outcomes from acute stroke [13,14], none has sought to examine the impact of UI on adverse health outcomes from UI independent of stroke severity, or indeed amongst patients with milder stroke symptoms. Analysis of the interaction between UI and stroke severity confirmed the important impact of UI on mortality amongst patients with milder stroke, whilst the effect of UI on disability by discharge was not influenced by the level of stroke severity. Our findings are therefore novel and have important implications for clinical practice (see Section Impact of UI on clinical practice below).

Risk of Nosocomial Infections, Malnutrition and LOS

Overall, our observations of a link between UI and these complications broadly agree with previous studies, including: pneumonia [23], UTI [23,24] and malnutrition [25], as well as LOS [26]. However, our findings differ from previous ones, where these complications related more strongly with UI amongst patients with milder stroke, particularly for the development of nosocomial infections. The increase in prolonged LOS on the HASU, risk of malnutrition, and nosocomial infections driven by UI form a vicious cycle, resulting in a reduced ability to recover after a stroke [19,27]. This might be explained by sarcopenia due to reduced mobility as muscle strength declines by ~5% for each day of hospitalisation [27].

In line with national guidelines [16], all patients in our study at risk of malnutrition were reviewed by a dietitian to provide appropriate nutritional support [19]. It is important to emphasise that routine screening for asymptomatic bacteriuria in men and non-pregnant women is not recommended by the National Institute for Health and Care Excellence, as it is not harmful, whilst the risk of treatment outweighs any benefit due to a risk of antibiotic resistance [28]. Our study has further added to this poorly documented area of research.

Risk of Care Support

Our study also found UI to relate to greater needs for palliative care, ADL support and care-home destinations, after discharge to the community, including those with milder stroke, and has implications about the ability to target better the greater care needs for post-stroke patients [29]. There are only a few studies on the influence of UI on ADL support, institutionalisation, and palliative care for such patients [8].

Impact of UI on Clinical Practice

The observation of increased rates of UI in proportion to greater stroke severity in this study is consistent with previously findings [13]. However, previous research often overlooked the influencing role of stroke severity on the impact of UI on stroke outcomes. Our study revealed a disproportionate risk of poor healthcare outcomes from UI in patients with milder stroke. The number of patients who had UI amongst those without stroke symptoms upon admission were >100, which is substantial. It should be borne in mind that the aim of our study was to examine UI and outcomes across the entire spectrum of stroke severity, which revealed that UI is also a risk factor even in milder forms of stroke. We presented the relative differences in outcomes between patients with versus those without UI within each category of stroke severity and found the risk of poor outcomes from UI were relatively higher in the milder group than in the severe group for certain outcomes. This observation does not imply that a greater number of UI amongst the more severe stroke groups is not clinically important. In patients with severe stroke, the severity of stroke was most likely to outweigh all the other factors included in the analysis for outcomes such as mortality, whilst UI was equally important for disability. This observation suggests an uncoupling of association between UI and stroke severity with respect to stroke outcomes.

The concept of a geriatric syndrome has been advocated by geriatricians to describe a cluster of common health conditions associated with poor health outcomes that frequently occur in older adults. These health components include delirium, falls, UI, and frailty [30], some of which, such as delirium, relate to poor outcomes in patients with stroke [31]. Indeed, UI is not simply a marker for the commonly used indicator of stroke severity (NHISS), but probably reflects other co-existing pathologies that are not captured by the NIHSS model, and possibly beyond the features defined by the geriatric syndrome. These factors may either be those predisposing individuals to stroke (e.g., smoking or obesity), or emerging after stroke (e.g., cognitive impairment, reduced mobility, falls, UTI, and medications).

Our study highlights the importance of post-stroke UI and a need to support this group, coupled with the fact that there is little research on the benefits of achieving continence [32], although plans to promote continence are important to this group of patients [33]. However, national data from the SSNAP report have shown that ≥5% of patients with stroke-related UI did not have continence management plans for applicable patients drawn up by discharge [16]. Greater training to promote the awareness of UI for all healthcare professionals is necessary to improve identification of this high-risk group. A survey of >600 Canadian allied health professionals showed that only ~40% of occupational therapists and physical therapists identified UI after stroke as a problem [34]. Furthermore, evidence on long-term continence management is lacking [32], despite a considerable proportion of patients who continue to have UI 2 years after an acute stroke [12]. Whilst continence plans focus on physical management of continence, they do not address sociopsychological aspects of UI, including embarrassment, sleep disruption, depression and distress, which affect the patient's ADL, quality of life, and social isolation [14,35].

Limitations

There were certain limitations to this study including its cross-sectional design, and a focus only on patients with an acute stroke. Therefore, our findings should not be generalised to patients with other acute conditions, nor to long-term consequences of stroke. Another limitation is the absence of information on patients with UI prior to stroke. The SSNAP protocol did not include rates of UI recovery after stroke and outcomes in the longer term. Furthermore, although it is well recognised that UI affects patients' quality of life, SSNAP does not record this measure, which should be considered in future research. This study, guided by the national audit protocol (SSNAP), did not document the specific types of UI such as stress, urge or overflow UI, or the severity of UI, which is a shortcoming for this type of research. In addition, information on the sites of stroke lesion were not recorded, which may be of interest as studies have shown UI is more common amongst patients with left-sided rather than right-sided stroke [36]. However, although the study recruited locally, the data were derived from a large cohort of patients admitted consecutively from one of the largest NHS regions in the UK, and with similar clinical characteristics to those from acute stroke patients in the UK [16].

Future Research

It is recommended that future research should quantify other characteristics of a stroke-specific geriatric syndrome. Other possible explanations for links between UI and poor outcomes may result from a difficulty for patients with UI to participate or respond successfully to stroke rehabilitation therapy [37,38]. Interventional studies are necessary to establish the effects of early identification and treatment for infections and malnutrition support amongst patients with UI to reduce adverse outcomes. There is also a need for further studies on the effects of early recognition and treatment of UI-related complications, such as nosocomial infections, on reduction of LOS. It would be of future interest for the SSNAP protocol to capture several other UI-related aspects to gain insight into the pathophysiology of UI after a stroke. First, recording pre-stroke UI would lessen bias on post-stroke UI and outcome measures. Second, other studies sub-categorise UI dependent on ensuing disabilities [8,39] to ascertain relative magnitudes of disability. Third, the pathophysiology of UI is multi-factorial, including associations with neural defects, myogenic bladder overactivity, outflow tract obstruction, and damage to the outlet sphincters [2]. It would be of interest to determine if stroke injury has a differential action on these pathophysiologies of UI.

Conclusions

This study has shown that UI is a useful indicator of poor short-term outcomes in hospitalised older patients admitted with an acute stroke and provides valuable information to healthcare professionals for identifying at-risk individuals, irrespective of stroke severity.

Acknowledgements

The authors wish to thank patients and all those who were involved in the surveys.

Contributor and Guarantor Information

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.

Disclosures of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and publication of this paper.

Funding

None.

Statement of Human and Animal Rights

This study was conducted in accordance with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This article does not contain any studies with animals performed by any of the authors.

Data Availability Statement

No additional data are available.

References

1 **Griffiths D**. Neural control of micturition in humans: a working model. *Nat Rev Urol* 2015; 12: 695–705

2 **Fry CH, Birder LA, Chess-Williams R** et al. Neural control and cell biology. In **Cardozo L, Rovner E, Wagg A, Wein A, Abrams P** eds, *Incontinence*, 7th edn, 2023: 132–246 Chapter 2, publ ICI-ICS. Bristol, UK: International Continence Society. ISBN: 978-0-9569607-4-0.

3 **Abrams P, Cardozo L, Fall M** et al. The standardization of terminology of lower urinary tract function: report from the standardization sub-committee of international continence society. In *Textbook of Female Urology and Urogynecology*. 2010: 1098–108. London, UK: CRC Press. ISBN: 9781003039983.

4 **Wyndaele M, Hashim H**. Pathophysiology of urinary incontinence. *Surgery (Oxford)* 2020; 38: 185–90

5 **Pettersen R, Haig Y, Nakstad PH, Wyller TB**. Subtypes of urinary incontinence after stroke: relation to size and location of cerebrovascular damage. *Age Ageing* 2008; 37: 324–7

6 **Stroke Association**. Bladder and bowel problems. Available at: https://www.stroke.org.uk/effects-of-stroke/physical-effects-of-stroke/continence-problems. Accessed 02 January 2024

7 **Wilson DA, Lowe D, Hoffman A, Rudd A, Wagg A**. Urinary incontinence in stroke: results from the UK National Sentinel Audits of stroke 1998–2004. *Age Ageing* 2008; 37: 542–6

8 **Kolominsky-Rabas PL, Hilz MJ, Neundoerfer B, Heuschmann PU**. Impact of urinary incontinence after stroke: results from a prospective population-based stroke register. *Neurourol Urodyn* 2003; 22: 322–7

9 **Williams MP, Srikanth V, Bird M, Thrift AG**. Urinary symptoms and natural history of urinary continence after first-ever stroke—a longitudinal population-based study. *Age Ageing* 2012; 41: 371–6

10 **Adams HP, Davis PH, Leira EC et al.** Baseline NIH stroke scale score strongly predicts outcome after stroke: a report of the trial of org 10172 in acute stroke treatment (TOAST). *Neurology* 1999; 53: 126–31

11 **John G, Bardini C, Mégevand P, Combescure C, Dällenbach P**. Urinary incontinence as a predictor of death after new-onset stroke: a meta-analysis. *Eur J Neurol* 2016; 23: 1548–55

12 **Patel M, Coshall C, Rudd AG, Wolfe CD**. Natural history and effects on 2-year outcomes of urinary incontinence after stroke. *Stroke* 2001; 32: 122–7

13 **Brittain KR, Peet SM, Castleden CM**. Stroke and incontinence. *Stroke* 1998; 29: 524–8

14 **Mehdi Z, Birns J, Bhalla A**. Post-stroke urinary incontinence. *Int J Clin Pract* 2013; 67: 1128–37

15 **Pizzi A, Falsini C, Martini M, Rossetti MA, Verdesca S, Tosto A**. Urinary incontinence after ischemic stroke: clinical and urodynamic studies. *Neurourol Urodyn* 2014; 33: 420–5

16 **Royal College of Physicians**. Clinical effectiveness and evaluation unit on behalf of the intercollegiate stroke working party. SSNAP. 2017 Available at: https://www.strokeaudit.org/Documents/National/Clinical/AprJul2017/AprJul2017-PublicReport.aspx. Accessed 11 Nov 2023

17 **Han TS, Gulli G, Affley B et al.** New evidence-based A1, A2, A3 alarm time zones for transferring thrombolysed patients to hyper-acute stroke units: faster is better. *Neurol Sci* 2019; 40: 1659–65

18 **Kondrup JE, Allison SP, Elia M, Vellas B, Plauth M**. ESPEN guidelines for nutrition screening 2002. *Clin Nutr* 2003; 22: 415–21

19 **Fluck D, Fry CH, Gulli G et al.** Association of risk of malnutrition with adverse outcomes and early support on discharge in acute stroke patients without prestroke disability: a multicenter, registry-based cohort study. *Nutr Clin Pract* 2022; 37: 1233–41

20 **National Institute for Health and Care Excellence**. Urinary incontinence in neurological disease: assessment and management Clinical guideline [CG148]. 2012 Last updated: 02 October 2023. Available at: https://www.nice.org.uk/guidance/cg148/resources/urinary-incontinence-in-neurological-disease-assessment-and-management-pdf-35109577553605. Accessed 02 January 2024

21 **Nakayama H, Jørgensen HS, Pedersen PM, Raaschou HO, Olsen TS**. Prevalence and risk factors of incontinence after stroke: the Copenhagen stroke study. *Stroke* 1997; 28: 58–62

22 **Cai W, Wang J, Wang L, Wang J, Guo L**. Prevalence and risk factors of urinary incontinence for post-stroke inpatients in southern China. *Neurourol Urodyn* 2015; 34: 231–5

23 **Keilani M, Lalouschek W, Mittlböck M, Greisenegger S, Crevenna R**. Urinary incontinence and early outcome after acute ischemic stroke. *Physikalische Medizin, Rehabilitationsmedizin, Kurortmedizin* 2014; 24: 321–5

24 **Brogan E, Langdon C, Brookes K, Budgeon C, Blacker D**. Can't swallow, can't transfer, can't toilet: factors predicting infections in the first week post stroke. *J Clin Neurosci* 2015; 22: 92–7

25 **Gariballa SE**. Potentially treatable causes of poor outcome in acute stroke patients with urinary incontinence. *Acta Neurol Scand* 2003; 107: 336–40

26 **Henriksen T**. Urinary incontinence after apoplexy. *Ugeskr Laeger* 1993; 155: 1107–9

27 **National Audit Office**. Discharging older patients from hospital. In *Report by the Comptroller and Auditor General*. London: NAO, 2016 Available at: http://www.nao.org.uk/wp-content/uploads/2015/12/Discharging-older-patients-from-hospital-Summary.pdf. Accessed 11 Nov 2023

28 **National Institute for Health and Care Excellence**. Urinary tract infections in adults. Quality standard [QS90]. 2015 Last updated: 15 February 2023. Available at: https://www.nice.org.uk/guidance/qs90/chapter/Quality-statement-3-Antibiotic-treatment-for-asymptomatic-bacteriuria-in-men-and-non-pregnant-women. Accessed 02 January 2024

29 **Xu XM, Vestesson E, Paley L et al.** The economic burden of stroke care in England, Wales and Northern Ireland: using a national stroke register to estimate and report patient-level health economic outcomes in stroke. *Eur Stroke J* 2018; 3: 82–91

30 **Inouye SK, Studenski S, Tinetti ME, Kuchel GA**. Geriatric syndromes: clinical, research, and policy implications of a core geriatric concept. *J Am Geriatr Soc* 2007; 55: 780–91

31 **Zipser CM, Deuel JW, Held JPO et al.** Economic impact of poststroke delirium and associated risk factors: findings from a prospective cohort study. *Stroke* 2021; 52: 3325–34

32 **Thomas LH, Coupe J, Cross LD, Tan AL, Watkins CL**. Interventions for treating urinary incontinence after stroke in adults. *Cochrane Database Syst Rev* 2019; 2: CD004462

33 **British Association of Urological Surgeons**. Available at: https://www.baus.org.uk/patients/conditions/5/incontinence_of_urine/. Accessed 11 Nov 2023

34 **Dumoulin C, Korner-Bitensky N, Tannenbaum C**. Urinary incontinence after stroke: identification, assessment, and intervention by rehabilitation professionals in Canada. *Stroke* 2007; 38: 2745–51

35 **Brittain KR, Shaw C**. The social consequences of living with and dealing with incontinence–a carers perspective. *Soc Sci Med* 2007; 65: 1274–83

36 **Gelber DA, Good DC, Laven LJ, Verhulst SJ**. Causes of urinary incontinence after acute hemispheric stroke. *Stroke* 1993; 24: 378–82

37 **Eldar R, Ring H, Tshuwa M, Dynia A, Ronen R**. Quality of care for urinary incontinence in a rehabilitation setting for patients with stroke. Simultaneous monitoring of process and outcome. *Int J Qual Health Care* 2001; 13: 57–61

38 **Turhan N, Atalay A, Atabek HK**. Impact of stroke etiology, lesion location and aging on post-stroke urinary incontinence as a predictor of functional recovery. *Int J Rehabil Res* 2006; 29: 335–8

39 **Wade DT, Collin C**. The Barthel ADL index: a standard measure of physical disability? *Int Disabil Stud* 1988; 10: 64–7

Correspondence: Thang S. Han, Institute of Cardiovascular Research, Royal Holloway University of London, Egham TW20 0EX, UK.

e-mail: thang.han@rhul.ac.uk

Abbreviations: ADL, activity of daily living; AF, atrial fibrillation; CHF, congestive heart failure; DM, diabetes mellitus; HASU, hyperacute stroke unit; ICH, intracranial haemorrhage; LOS, length of stay; MLR, multivariable logistic regression; mRS, modified Rankin Scale; NIHSS, National Institutes of Health Stroke Scale; OR, odds ratio; SSNAP, Sentinel Stroke National Audit Programme; UI, urinary incontinence.

Supporting Information

Additional Supporting Information may be found in the online version of this article:

Fig. S1 Rates of high risk of malnutrition (**A**), ADL support requirement (**B**), discharge to care homes (**C**), pneumonia (**D**), and UTI (**E**) within 7 days of admission, and palliative care by discharge (**F**) amongst patients presenting with different severity of acute stroke with or without UI.

Table S1. Rates of UI according to age, sex, and comorbidities.