Management of fever, hyperglycemia, and swallowing dysfunction following hospital admission for acute stroke in New South Wales, Australia

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Background **Fever, hyperglycemia, and swallow dysfunction poststroke are associated with significantly worse outcomes. We report treatment and monitoring practices for these three items from a cohort of acute stroke patients prior to randomization in the Quality in Acute Stroke Care trial.**

Method **Retrospective medical record audits were undertaken for prospective patients from 19 stroke units. For the first three-days following stroke, we recorded all temperature readings and administration of paracetamol for fever (≥37·5°C) and all glucose readings and administration of insulin for hyperglycemia (>11 mmol/L). We also recorded swallow screening and assessment during the first 24 h of admission.**

Results **Data for 718 (98%) patients were available; 138 (19%) had four hourly or more temperature readings and 204 patients (29%) had a fever, with 44 (22%) receiving paracetamol. A quarter of patients (*n* = 102/412, 25%) had six hourly or more glucose readings and 23% (95/412) had hyperglycemia, with 31% (29/95) of these treated with insulin. The majority of patients received a swallow assessment (*n* = 562, 78%) by a speech pathologist in the first instance rather than a swallow screen by a nonspeech pathologist (*n* = 156, 22%). Of those who passed a screen (*n* = 108 of 156, 69%), 68% (*n* = 73) were reassessed by a speech pathologist and 97% (*n* = 71) were reconfirmed to be able to swallow safely.**

Conclusions **Our results showed that acute stroke patients were: undermonitored and undertreated for fever and hyperglycemia; and underscreened for swallowing dysfunction and unnecessarily reassessed by a speech pathologist, indicating the need for urgent behavior change.**

Key words: fever, hyperglycemia, insulin, paracetamol, stroke, swallow screen

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For the protocols and information about the intervention, see http://www.acu.edu.au/qasc

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Introduction

In the first few days of an acute stroke, fever occurs in 12–50% of patients (1–4), hyperglycemia occurs in more than 40% of patients (5,6), and swallowing dysfunction occurs in 37–78% of patients (7). All three variables in the early poststroke period are associated with a significant increase in morbidity and mortality (8–10) (7,11). The administration of paracetamol has been found to be an effective therapy in reducing fever among patients with stroke (12) as has the treatment of hyperglycemia with insulin following acute stroke in reducing glucose levels (13). However, there is currently no clinical evidence that tight glycemic control during the acute stroke phase improves outcomes (13). Studies have shown that nonspeech pathologists can safely perform swallowing screening before a speech pathologist comprehensive assessment for those who fail the screen (14–16) and the use of a formal dysphagia screening protocol has been associated with improved compliance with dysphagia screening and a significantly reduced risk of pneumonia (17).

To ensure optimum outcomes for stroke patients, early detection and treatment of fever, hyperglycemia, and swallowing dysfunction following acute stroke should be a priority (18). International guidelines from the United Kingdom (19), United States (20), Europe (21), Canada (22), and Australia (23) (Box 1) recommend similar monitoring and treatment practices for the management of fever, hyperglycemia, and swallowing; however, these recommendations are generally nonspecific, that is, only the Canadian guidelines included a recommendation specific to the frequency of temperature monitoring within the first 48 h

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Box 1 International guideline recommendations for fever, hyperglycemia, and swallowing dysfunction^

	United Kingdom (19)	Europe (21)	United States (20)	Canada (22)	Australia (23)
Fever management					
Monitoring targets and time frame	Not stated	Not stated	Not stated	'Every 4 h for first 48 hours'	'Routinely and frequency determined by the patients status'
Treatment target	Not stated	>37·5°C	Not stated	>37·5°C	Not stated
Paracetamol or antipyretic medication recommended	No	Yes	Yes	Yes	Yes
Hyperglycemia management					
Venous blood glucose					
Monitoring targets	Not stated	'Initial examination should include..blood samples for clinical chemistry, glucose'	'Several tests should be performed routinely . . . These test include blood glucose'	'All patients with suspected acute stroke should have their blood glucose concentration checked immediately'	'The following investigations should be obtained routinely. . . glucose'
Finger-prick blood glucose					
Monitoring targets and time frame	Not stated	'Check regularly'	Not stated	'Check immediately'	'Routinely and frequency determined by the patients status'
Treatment target	'Maintain between 4 and 11 mmol/l'	Not stated	'Lower markedly elevated glucose levels to 300 mg/dl (16·7 mmol/l)'	Not stated	Not stated
Insulin for hyperglycemia recommended	No	No	Yes	Yes	Yes
Swallowing dysfunction management					
Swallow screen (nonspeech pathologist)	'On admission' 'Before being given any oral food, fluid or medication'	Not stated	Not stated	'Part of their initial assessment, and before initiating oral intake of medications, fluids or food' 'If not alert within the first 24 h'	'Within 24 h of admission and before being given any oral food, fluid or medication'

^ As published at time of QASC intervention implementation period (May 2007 to Aug 2010).

following admission for acute stroke (every four-hours) (22). Four of these five guidelines recommended that paracetamol be used routinely to treat fever (18,20–23), but only two provided a threshold for treatment (>37·5°C) (21,22). No guidelines included recommendations specific to the frequency of glucose monitoring following stroke diagnosis and insulin was recommended for treatment of hyperglycemia in three of the five guidelines (20,22,23), with only two providing a threshold for treatment [maintain between 4 and 11 mmol/l; lower glucose levels to 300 mg/dl (16·7 mmol/l)] (Box 1) (19,20). For the management of swallowing dysfunction following acute stroke, of the five guidelines reviewed, three recommended a swallow screen (by nonspeech pathologist) be undertaken within the first 24 h of admission to the hospital and prior to being given food, drink, or oral medications (19,22,23). Two of the three guidelines recommending a swallow screen also recommended a comprehensive swallow assessment (by speech pathologist) for those with a failed screen (19,23). One of the guidelines recommended a swallow assessment but no swallow screen (21). One guideline failed to include any recommendation pertaining to the management of swallowing dysfunction (20).

The Quality in Acute Stroke Care Trial (QASC) (24,25), a cluster randomized controlled trial, was designed to test the effect of a multidisciplinary team building intervention to implement evidence-based treatment protocols for the management of fever, hyperglycemia, and swallowing dysfunction on 90-day poststroke outcomes and clinician behavior change. Panels of experts developed three clinical treatment protocols using recommendations

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Box 2 QASC trial clinical treatment protocols (also referred to as FeSS [**f**ever, **s**ugar, **s**wallow] protocols)*

Fever
1. Temperature monitored and charted four hourly for 72 h following stroke unit admission.
2. Temperature ≥37·5°C treated with paracetamol (IV, PR, or oral).

Sugar (hyperglycemia)
1. Venous blood glucose measured (venous blood not finger prick) on admission to hospital.
2. At least six hourly finger-prick blood glucose readings for 72 h following stroke unit admission.
3. On admission to stroke unit, if blood glucose level:
   >11 mmol/l and known diabetic, commence insulin (IV or SC).
   >16 mmol/l and patient without known diabetes, commence insulin (IV or SC).
4. If blood glucose level >11 mmol/l at any time in first 72 h following stroke unit admission, commence insulin.

Swallowing dysfunction
1. Swallow screen within 24 h of stroke unit admission if not attended in the emergency department.
2. Patients who fail the swallow screen refer to a speech pathologist for a swallowing assessment.

Key:
IV, intravenous; PR: per rectum; QASC, Quality in Acute Stroke Care Trial; SC, subcutaneous.
*Further information about the QASC trial including the treatment protocols and QASC medical record audit tool is available at http://www.acu.edu.au/qasc

from Australia's national clinical guidelines for stroke (23). The protocols included specific monitoring and treatment targets for fever, hyperglycemia, and swallowing dysfunction (Box 2). Our monitoring and treatment target for fever (37·5 C) was consistent with international guideline recommendations (19,21,22). With regard to glucose monitoring, our protocol recommended six hourly monitoring when nonhyperglycemic, with more frequent monitoring only when the glucose was elevated. Nurses have a duty of care to monitor patients, particularly in the acute phase, and these frequencies seem an appropriate minimum in the absence of data. We acknowledge the lack of evidence for tight glycemic control, hence our protocols did not support this. Instead, we aimed to treat major episodes of hyperglycemia in accordance with guideline recommendations (18,23). Similarly, our monitoring and treatment targets for swallowing dysfunction following acute stroke were consistent with our national stroke guidelines published prior to and after the commencement of the QASC trial (18,23). To date, it is unknown what effect comprehensive and standardized management protocols for these three variables would have on patient management and outcomes. Prior to randomization and implementation of the protocols within the QASC trial, we aimed to establish baseline practices for the monitoring and treatment of fever (temperature ≥ 37·5°C); hyperglycemia (glucose level >11 mmol/l), and swallowing dysfunction. This was also a unique opportunity to investigate clinician adherence with recommendations pertaining to the management of fever, hyperglycemia, and swallowing dysfunction following acute stroke from the Australian Clinical Guidelines for Acute Stroke Management (18).

Method

Retrospective medical record audits were undertaken from January to November 2009 of patients prospectively recruited between July 2005 and October 2007 (for the preintervention cohort of the QASC trial).

Participants

Nineteen hospitals in New South Wales (NSW), Australia that had Categories A and B acute stroke units (those that had immediate access to brain imaging and high dependency units) (26) were eligible to participate. Eligible patients were those admitted to these stroke units within 48 h of developing stroke symptoms; were diagnosed with an ischemic stroke or intracerebral hemorrhage; were greater than 18 years of age; spoke English; and had access to a telephone. Patients who died while in hospital were still included in the audit if they met the eligibility criteria and were managed in a participating stroke unit. Patients who were diagnosed with severe stroke and referred for palliation were excluded from the study.

Outcome measures

All outcomes were derived from the protocols (Box 2) and were measured at the individual or event level (Tables 2, 3 and 4 and 5).

Data collection

Four auditors, not otherwise involved in the QASC trial and blind to the study design, collected the audit data as follows: all temperature readings and administration of paracetamol for fever (≥37·5°C) over the first 72 h of admission to the stroke unit; all finger-prick glucose readings and administration of insulin for hyperglycemia (>11 mmol/L) over the first 72 h of admission to the stroke unit; venous blood glucose levels in the emergency department or within two-hours of stroke unit admission; and swallowing surveillance including swallowing screens by non-speech pathologists and comprehensive swallowing assessments by speech pathologists within the first 24 h of hospital admission. To meet the criteria for a successful swallowing screening, all the three following individual elements had to be documented: level of consciousness, cranial nerve assessment (specifically cranial nerves IX, X and XI), and a water swallow test. Alternatively, a hospital approved swallowing screen tool (with these three components) had to be completed. In our participating hospitals, and common practice within NSW at this time, speech pathologists

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perform a full swallow assessment when called to see patients; swallow screens were performed only by nonspeech pathologists.

Auditors also collected information on: age, gender, stroke subtype (Oxfordshire Community Stroke Project classification) (27); stroke severity [Scandinavian Stroke Scale (SSS)] (28); level of disability on admission (modified Rankin Scale [mRS]) (29); date and time of symptom onset; date and time of admission to the emergency department (where relevant); date and time of admission to the stroke unit; hospital discharge date; death during hospitalization; and diabetic status. The QASC audit tool and data dictionary are accessible via http://www.acu.edu.au/qasc.

Auditors attended a two-day training program. Audits were conducted by two pairs of auditors who undertook dual independent data abstraction, enabling clarification of uncertainties. For quality assurance purposes, 10% of patient records were re-audited.

This study was approved by the Human Research Ethics Committee of the Australian Catholic University and the relevant Human Research Ethics Committees of all participating hospitals.

Data analysis

Analyses were undertaken using STATA 11·0 software (StataCorp, Blackburn North, Victoria, Australia). Frequency distributions of socio-demographic and clinical characteristics of the sample are presented. Because patients who experience fever and hyperglycemia had an increased number of readings recorded, we computed a mean temperature and blood glucose reading for each patient for the first 72 h following stroke unit admission, and using these, then determined the sample mean temperature and glucose level (i.e., mean of the patient mean values). Because paracetamol can only be administered 4–6 hourly within 24 h (30), the analysis was restricted to treatment of the first febrile event only. The number and proportion of patients with each outcome (for binary measures), means and standard deviations for normally distributed continuous variables or medians and quartiles for nonnormally distributed continuous variables are presented with 95% confidence intervals (CIs), with exact CIs obtained for medians using the binomial method (31). Comparisons for hyperglycemic management between patients with diabetes and patients without a history of diabetes were carried out using the Wald chi-square test adjusted for clustering by hospital.

Results

Of the 735 eligible QASC consenting patients, 17 medical records were unable to be located and 718 (98%) patients had their data audited (missing data 2·3%).

Almost half of the patients ($n = 307$ of 630; 49%) were aged 75 or above and over half ($n = 403$, 57%) were male. Thirty-nine percent of patients ($n = 218$ of 558) had a Partial Anterior Circulation Infarct (32). The majority of patients had an SSS of >30 [$n = 427$ (84%) of 506], indicating a mild to moderate stroke (28), and just under half the patients had an admission mRS ≥ 2 [$n = 330$ (49%) of 674] which indicated some degree of dependency or death. Eight patients (1%) died while in hospital. Most patients ($n = 640$, 89%) were admitted to the stroke unit via the emergency department, and the median time spent in the emergency department prior to transfer to the stroke unit was 7·4 h ($n = 640$) (Q1 5·7, Q3 10·1). The median hospital length of stay was 8 days (Q1 6, Q3 12) (Table 1).

Table 1 Demographic and clinical characteristics*,†

	n	%
Age ($n = 630$)		
<65	168	27
65–74	155	25
75–84	228	36
>85	79	13
Gender ($n = 712$)		
Male	403	57
Female	309	43
Mortality status ($n = 718$)		
Survived	710	99
Died while in hospital	8	1
Admission to stroke unit via ($n = 718$)		
Emergency department	640	89
Other	78	11
Oxfordshire Community Stroke Project ($n = 558$)		
Partial anterior circulation infarct	218	39
Lacunar infarct	141	25
Posterior circulation infarct	81	15
Total anterior circulation infarct	49	9
Intracerebral hemorrhage	39	7
Trans ischemic attack	30	5
Scandinavian Stroke Score ($n = 506$)		
0–14 (Very severe)	34	7
15–29 (Severe)	45	9
30–44 (Moderate)	126	25
45–58 (Mild)	301	59
Modified Rankin Score documented in the emergency department or within 72 h of stroke unit admission ($n = 674$)		
0 – No symptoms at all	108	16
1 – No significant disability despite symptoms	236	35
2 – Slight disability	103	15
3 – Moderate disability	106	16
4 – Moderately severe disability	30	4
5 – Severe disability	48	7
6 – Dead	43	6

*Percents may not total to 100%, due to rounding.
†Denominators vary due to missing data.

Management of fever

Temperature was recorded at least once within 72 h of stroke unit admission for 714 patients (99%), of whom 138 (19%, 95% CI 16–22%) had one or more temperature readings every four-hours. The mean temperature reading within the first 72 h of admission to the stroke unit was 36·6°C (SD 0·30). During this period, 204 patients (29%, 95% CI 25–32%) had a temperature reading ≥ 37·5°C, of whom 44 (22%, 95% CI 16–27%) received paracetamol within two-hours of the first febrile event. The median time to administration of paracetamol [for those where time of temperature reading and/or paracetamol administration time was documented ($n = 41$) for the first instance of fever (≥37·5°C)] was 30 min (Q1 10, Q3 120 min) (Table 2).

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Table 2 Fever processes of care measures

Outcome	Eligible sample	*n* (%)	95% CI
Monitoring			
Patients with at least one temperature reading recorded every four-hours or more within the first 72 h of stroke unit admission	714	138 (19%)	16% to 22%
Mean temperature reading within first 72 h of stroke unit admission (°C) (for those who had at least one temperature reading)	714	36·63 (0·30)*	36·61 to 36·65
Patients with a febrile event (temperature ≥37·5°C) within the first 72 h of stroke unit admission (for those who had at least one temperature reading)	714	204 (29%)	25% to 32%
Treatment			
Patients administered paracetamol within two-hours when temperature ≥37·5°C (at first febrile event)	204	44 (22%)	16% to 27%
Time (minutes) to administration of paracetamol when temperature ≥37·5°C at first febrile event (for those who received paracetemol)	41 of 44‡	30 (10, 120)†	57 to 314

*Mean of means (SD).
†Median (Q1, Q3).
‡Data are missing.

Table 3 Hyperglycemia processes of care measures

Outcome	Eligible sample	*n* (%)	95% CI
Monitoring			
Patients with a formal venous glucose measurement in the emergency department or within two-hours of stroke unit admission	718	186 (26%)	23% to 29%
Mean formal venous glucose measurement taken in the emergency department or within two-hours of stroke unit admission	186	6·4 (SD 2·6)	6·1 to 6·6
Patients with at least one finger-prick glucose reading taken within the first 72 h of stroke unit admission	718	412 (57%)	54% to 61%
Patients with finger-prick glucose reading recorded within two-hours of stroke unit admission (for those who had at least one finger-prick glucose reading)	412	158 (38%)	34% to 43%
Patients with at least one finger-prick blood glucose reading recorded every six-hours within 72 h of stroke unit admission (for those who had at least one finger-prick glucose reading)	412	102 (25%)	21% to 29%
Mean finger-prick glucose reading recorded within 72 h of stroke unit admission (mmol/l) (for those who had at least one finger-prick glucose reading)	412	7·1 (2·0)*	6·9 to 7·3
Patients with a hyperglycemic event (finger-prick blood glucose >11 mmol/l) within 72 h of stroke unit admission (for those who had at least one finger-prick glucose-reading)	412	95 (23%)	19% to 27%
Treatment			
Patients treated with insulin when finger-prick blood glucose >11 mmol/l	95	29 (31%)	21% to 40%
Time (mins) to administration of insulin when first finger-prick blood glucose >11 mmol/l (for those administered insulin)	9 of 29‡	11 (0, 26)†	–20 to 109

*Mean of means (SD).
†Median (Q1, Q3).
‡Data are missing.

Management of hyperglycemia

Just over one quarter of the patients ($n = 186$, 26%, 95% CI 23–29%) had a formal venous blood glucose (nonfinger-prick) measured in the emergency department or within two-hours of stroke unit admission. The mean formal venous blood glucose measurement taken in the emergency department or within two-hours of stroke unit admission was 6·4 (SD 2·6). A finger-prick glucose reading was recorded at least once within the first 72 h of stroke unit admission for 412 (57%) patients, of whom 158 (38%, 95% CI 34–43%) had a finger-prick glucose reading recorded within two-hours of stroke unit admission and 102 patients (25%, 95% CI 21–29%) had at least one or more finger-prick glucose readings every six-hours. The mean finger-prick glucose reading for those who had had at least one finger-prick glucose reading ($n = 412$) was 7·1 mmol/l (SD 2·0). Ninety-five of the 412 patients (23%, 95% CI 19–27%) had a finger-prick glucose reading >11 mmols/l. Twenty-nine (31%, 95% CI 21–40%) of these hyperglycemic patients were treated with insulin, with the median time to treatment of first hyperglycemic episode being 11 min (Q1 0, Q3 26 min) (Table 3).

A history of diabetes was documented for 115 patients (16%). Patients with known diabetes ($n = 115$) were significantly more likely when compared with patients without known diabetes to receive: a venous blood glucose in the emergency department or within two-hours of stroke unit admission (39% versus 23%, $P = 0·002$); a finger-prick glucose reading at any time within the first 72 h of stroke unit admission (94% versus 50%, $P = < 0·001$); at least one finger-prick glucose reading within two-hours of

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Table 4 Hyperglycemia processes of care measures among patients with known diabetes and patients without known diabetes

Outcome	Patients with known diabetes $n = 115$ n (%)	Patients without known diabetes $n = 603$ n (%)	P*	Difference between groups (95% CI)†
Monitoring				
Patients with a formal venous glucose measurement in the emergency department or within two-hours of stroke unit admission	45 (39)	141 (23)	0·002	15% (6% to 24%)
Patients with at least one finger-prick glucose reading taken within the first 72 h of stroke unit admission	108 (94)	304 (50)	<0·001	40% (33% to 48%)
Patients with finger-prick glucose reading recorded within two-hours of stroke unit admission (for those who had at least one finger-prick glucose reading)	54 of 108 (50)	104 of 304 (34)	0·002	17% (6% to 28%)
Patients with at least one finger-prick blood glucose reading recorded every six-hours within 72 h of stroke unit admission (for those who had at least one finger-prick glucose reading)	76 of 108 (70)	26 of 304 (9·0)	<0·001	62% (53% to 71%)
Patients with at least one finger-prick blood glucose reading >11 mmol/l (for those who had at least one finger-prick glucose reading)	70 of 108 (65)	25 of 304 (8)	<0·001	50% (47% to 66%)
Treatment				
Patients treated with insulin when finger-prick blood glucose >11 mmol/l (for those who had at least one finger-prick glucose reading)	25 of 70 (36)	4 of 25 (16)	0·01	23% (5% to 40%)

*P values are from Wald chi-square test.
†Adjusted for clustering of patients within stroke units; thus, is not necessarily equal to the absolute difference in percentages between groups.

stroke unit admission (50% versus 34%, $P = 0·002$); at least one or more finger-prick glucose readings sixth hourly within the first 72 h of stroke unit admission (70% versus 9%, $P = < 0·001$); and be treated with insulin when finger-prick glucose reading >11 mmols/l (36% versus 16%, $P = 0·01$) (Table 4).

Among patients with known diabetes, 26 (23%) had a finger-prick reading >11 mmols/l within the first two-hours of stroke unit admission (first finger-prick), and of these, 11 patients (42%) were administered insulin. Among patients without known diabetes, only one had a finger-prick reading >16 mmols/l on admission to the stroke unit. This patient was not treated with insulin (Table 4).

Management of swallowing dysfunction

The majority of patients ($n = 662$, 92%, 95% CI 90–94%) underwent swallowing surveillance either in the form of a swallow screen by a nonspeech pathologist ($n = 156$, 22%) or swallow assessment by a speech pathologist ($n = 506$, 78%) within 24 h of hospital admission. The majority of screens ($n = 149$, 96%, 95% CI 92–99%) were conducted in the emergency department and only seven (7) screens (4%, CI 1–9%) were conducted in the stroke unit (Table 5).

Of those patients who underwent a screening by a nonspeech pathologist within 24 h of admission ($n = 156$, 22%), 48 patients (31%, 95% CI 23–38%) were deemed to have an unsafe swallow, of whom 47 (98%) were then reviewed by a speech pathologist and underwent a swallow assessment. Of those who were seen by the speech pathologist and had an assessment, nine (19%, 95% CI 7–31%) were deemed to have dysphagia. The median time between failing a swallow screen (by nonspeech pathologist) and a swallow assessment by a speech pathologist was 23·3 h (Q1 5·7 h, Q3 47·6 h) (Table 5).

An analysis to determine if patients who had passed a screen and were then further unnecessarily assessed by a speech pathologist showed that of the 108 patients (69%) who passed the swallowing screen, 73 (68%) had a full assessment subsequently performed by a speech pathologist. Of those who were re-assessed, 97% ($n = 71$, 95% CI 93–99%) were deemed by the speech pathologist to have a safe swallow.

Discussion

The aim of our study was to investigate current management practices for fever, hyperglycemia, and swallowing dysfunction following stroke. We acknowledge that there is a lack of data to support tight monitoring and treatment of fever and hyperglycemia in the acute phase following stroke. However, we argue that nurses have a duty of care to monitor patients regularly, particularly in the acute phase, and treat according to best evidence. Four hourly temperature monitoring for the first 72 h, as stipulated in our protocol, is consistent with international guideline recommendations (22). Furthermore, it also allows for early identification of fever from other causes such as infection (i.e., aspiration pneumonia). With regard to glucose monitoring, our protocol recommended six hourly monitoring when nonhyperglycemic, with more frequent monitoring only when the glucose was elevated. Again, these frequencies seem an appropriate minimum in the absence of data. Our results indicate that the monitoring and treatment for fever and hyperglycemia in NSW stroke units were suboptimal. Although our national stroke guidelines recommend that all stroke patients be screened for swallowing dysfunction, clinician adherence with these guideline recommendations is poor and urgent behavior change is required.

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Table 5 Swallowing dysfunction processes of care measures

Outcome	Eligible sample	*n* (%)	95% CI
Monitoring			
Patients who underwent swallow surveillance in the form of a swallow screen and/or swallow assessment within 24 h of hospital admission	718	662 (92)	90% to 94%
Patients who underwent a swallow screen (by nonspeech pathologist) in the emergency department or within 24 h of stroke unit admission	718	156 (22)	19% to 25%
Patients who underwent a swallow screen (by nonspeech pathologist) in the emergency department (for those who had a swallow screen)	156	149 (96)	92% to 99%
Patients who underwent a swallow screen (by nonspeech pathologist) in the stroke unit and within 24 h of stroke unit admission (for those who had a swallow screen)	156	7 (4)	1% to 9%
Suspected dysphagia (for those who had a swallow screen by nonspeech pathologist	156	48 (31)	23% to 38%
Treatment			
Proportion who underwent a speech pathologist assessment following suspected dysphagia (for those who had failed the swallow screen undertaken by nonspeech pathologist)	48	47 (98)	94% to 100%
Deemed to have an unsafe swallow by speech pathologist and placed nil by mouth	47	9 (19)	7% to 31%
Time (hours) to speech pathologist assessment following a failed swallowing screening*	7 of 48‡	23·27 (5·68, 47·55)†	4·08 to 45·57

*Mean (SD).
†Median (Q1, Q3).
‡Data are missing.

Management of fever

Fever occurred in approximately one third of patients which is consistent with prior studies that have defined fever as ≥37·5°C (3,33). Comparisons with other studies are difficult because of differences in fever definition. In our study, only 19% of patients had at least one temperature reading recorded four hourly within the first 72 h following stroke unit admission. Furthermore, poor fever management practices were noted, with only 22% of patients with fever treated with paracetamol at their first febrile event. A failure to monitor patients and treat temperature is of concern, considering that fever has been associated with poor outcomes following stroke (8,33–36), and that paracetamol has been found to be an effective therapy in reducing fever among patients with stroke (12,37).

Little is known about which individual aspects of fever, that is, level of fever or duration, are associated with poor outcomes (38,39). Although the administration of paracetamol was timely (median 30 min), further studies exploring temperature duration and associated outcomes are required. This is one of the first studies reporting how quickly fever is treated in acute stroke patients.

Management of hyperglycemia

Only 23% of stroke patients, who had a finger-prick glucose measurement within the first 72 h of stroke unit admission, experienced a hyperglycemic event (finger-prick glucose >11 mmol/l) which is lower than the 43–68% previously reported (9). This may be attributed to our definition of hyperglycemia (finger-prick glucose >11 mmol/l), which is higher than that reported in prior studies (6·1–10 mmol/l) (9).

Despite guidelines recommending glucose testing following stroke, 74% of acute stroke patients in our study did not have a venous blood glucose measured in the emergency department or within two-hours of stroke unit admission. During the first 72 h of stroke unit admission, 43% of acute stroke patients had no finger-prick glucose monitoring. Of those who had their finger-prick glucose monitored ($n = 412$, 57%), only 25% had at least one finger-prick glucose level recorded every six-hours. A failure to monitor the patient's glucose levels frequently, or at all, may result in hyperglycemia being undetected, despite the association of hyperglycemia in the early poststroke period with worse outcomes (9,10). Patients without known diabetes were less likely to have a venous blood glucose measurement, nor finger-prick glucose monitoring at any time in the first 72 h of stroke unit admission compared with patients with known diabetes, but even among those with known diabetes, the level of testing was extremely poor. Furthermore, patients without known diabetes were also less likely to have hyperglycemic events treated with insulin. This is of concern, considering that stroke patients without known diabetes who have even moderately elevated glucose levels (>6·7 to 8 mmol/l) on admission have a threefold risk of death relative to known diabetic patients with this same level of elevated glucose (9).

Our findings indicate suboptimal treatment of hyperglycemia following acute stroke which has also been reported in prior studies (40). In our study, only 31% of patients received corrective treatment for a hyperglycemic event (finger-prick glucose >11 mmol/l) with insulin, and it is clear that more effort to optimize glucose control is needed. Clinicians failed to recognize that hyperglycemia is a significant event in stroke regardless of diabetes status.

Management of swallowing dysfunction

The majority of patients (92%) in our cohort underwent swallowing surveillance within 24 h of hospital admission. Although international guidelines recommend that patients only receive a swallow assessment following a failed screen (19,23), our results indicate that the majority of patients received a comprehensive speech pathologist assessment (78%) and no swallow screen.

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That 68% of patients who had passed a swallow screen subsequently also received a full speech assessment by a speech pathologist is of note. It is possible that this additional surveillance may have been unnecessary because 97% of patients initially screened by a nonspeech pathologist and passed were also deemed to have a safe swallow following an assessment by the speech pathologist. However, we acknowledge the small, but unlikely, possibility that all of these patients deteriorated and required a subsequent speech pathologist consultation.

The majority of screens were conducted in the emergency department (96%) rather than in the stroke unit (4%). We did not investigate whether a patient received food, fluids, or medications prior to a screen; and if a patient had received food, fluids, or medications in the emergency department, this may have been a deterrent for any further screening in the stroke unit as stroke unit nurses may have assumed the patient had previously been deemed to have a safe swallow. Further exploration of administration of food, fluids, or medications before swallowing screen or assessment is warranted.

Our results also indicated that a patient who failed a screen by a nonspeech pathologist was required to wait nearly 24 h nil by mouth before undergoing a speech pathologist assessment. Further studies exploring contributions to lengthy waiting times for a speech pathologist assessment are required.

Our study was limited to the investigation of the monitoring and treatment for fever, hyperglycemia, and swallowing dysfunction in the first 72 h of stroke unit admission. Other studies have examined these parameters up to seven-days (35,41); however, the majority of febrile episodes (58%) have been found to occur in the first 72 h of admission (39). Data were not collected on the route of the temperature measurement because this was rarely documented. We were unable to identify from the medical records whether nonspeech pathologist personnel who undertook the swallow screenings were specifically trained in swallowing screening or whether any screening tools used had been validated. However, we acknowledge the following strengths of our study. We included a large cohort of patients from 19 stroke units, thus enhancing generalizability; we also recorded all temperature and hyperglycemic measurements, thus we have complete data on the etiology of fever and hyperglycemic events within the first 72 h following a stroke.

In conclusion, the management of fever, hyperglycemia, and swallowing dysfunction in the acute phase following stroke was suboptimal, indicating the need for urgent behavior change. Our review of international guideline recommendations pertaining to the management of fever, hyperglycemia, and swallowing dysfunction highlighted that standardized recommendations for the monitoring and treatment of fever, hyperglycemia, and swallowing dysfunction following acute stroke do not exist. The QASC trial (24) has developed evidence-based protocols with specific monitoring and treatment targets for these three physiological variables. Prior studies have identified that the distribution alone of guidelines and protocols will not change clinician behavior (42), thus further research is required to identify effective behavior change interventions to promote the uptake of guideline and protocol recommendations. Our data provide preintervention processes of care measures to determine the effect of our standardized protocols for the management of fever, hyperglycemia, and swallowing dysfunction following acute stroke on clinician behavior change and ultimately patient outcomes.

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