Barriers and enablers to implementing clinical protocols for fever, hyperglycaemia and swallowing dysfunction in the QASC Trial – mixed methods study

INTRODUCTION

In the early post-stroke period elevation of both body temperature and blood glucose is associated with significantly worse stroke outcomes (Azzimondi et al., 1995; Greer, Funk, Reaven, Ouzounelli, & Uman, 2008; Pulsinelli, Levy, Sigsbee, Scherer, & Plum, 1983; Wang, Lim, Levi, Heller, & Fisher, 2000; Weir, Murray, Dyker, & Lees, 1997). In the first days of an acute stroke, elevation of temperature above 37.5ºC occurs in one fifth to almost one half of patients(Castillo, Davalos, Marrugat, & Noya, 1998) and the detrimental effects of fever following stroke are attributed to increased cerebral metabolic demands (Ginsberg & Busto, 1998), changes in the blood-brain barrier permeability, acidosis and an increased release of excitatory amino acids (Busto et al., 1989) which causes infarct expansion (Boysen & Christensen, 2001). There also is a significant association between post-stroke hyperglycaemia and poor recovery (Williams et al., 2002). Up to 68% of all patients experience hyperglycaemia with the first 24 hours of their acute stroke. (Allport et al., 2006; Scott et al., 1999) Hyperglycaemia following stroke has been shown to increase infarct size (Allport, Baird, & Davis, 2008; Pulsinelli et al., 1983) and lead to poorer outcomes independent of the patient's pre-stroke history of diabetes.(Pulsinelli et al., 1983; Weir et al., 1997) The incidence of dysphagia in the acute post stroke period ranges from 37% to 78% (Martino et al., 2005) and stroke patients with dysphagia are three times more likely to develop pneumonia than those without dysphagia (Doggett et al., 2001; Martino et al., 2005). Thus, optimal management of these three common physiological disturbances, namely, fever, hyperglycaemia and dysphagia are important elements of organised stroke care with potential to significantly influence outcomes. All three have been identified in international guidelines, as priority care issues for inpatient stroke management (Adams et al., 2007;

European Stroke Organisation (ESO) Executive Committee & ESO Writing Committee, 2008; National Institute for Health and Clinical Excellence, 2008; National Stroke Foundation, 2007, 2010).

Changing clinician practice remains a challenge (Morris, Wooding, & Grant, 2011) Successful translation of evidence into practice requires redress of barriers that generally might include disagreement among experts about best practice, attractiveness of alternative practices, inapplicability of guidelines to certain patient subgroups, institutional inertia, vested interests and ineffective continuing education (Grimshaw, Eccles, & Tetroe, 2004; Grol & Grimshaw, 2003). Production of up-to-date evidence-based clinical guidelines without targeted implementation strategies does not ensure practice change (Grimshaw J. M. et al., 2004). The need to identify and overcome barriers during implementation is well accepted (Grol et al., 2003).

In an effort to improve management of fever, hyperglycaemia and swallowing following stroke, the Quality in Acute Stroke Care (QASC), a cluster randomised control trial, evaluated the effectiveness of implementation of evidence-based clinical treatment protocols for the management of fever**,** glucose (sugar) and swallowing difficulties (the **Fe**ver, **S**ugar, **S**wallow [FeSS] protocols) to improve 90-day patient outcomes. In brief, the protocols consisted of: monitoring and treatment of temperatures $\geq$ 37.5ºC; treatment of major hyperglycaemia (fingerprick blood glucose levels $\geq$ 11 mmol/L for diabetics and $\geq$16 mmol/L for non-diabetics) with saline initially and/ or insulin; and the training of nurses to undertake swallowing screening using the ASSIST screening tool (Managers of Great Metropolitan Speech Pathology Services in NSW Health, 2004) with referral to a speech pathologist for full swallowing assessment only when patients failed the screen. Evidence-based strategies

used to facilitate implementation were; multidisciplinary team building workshops (Hamilton, McLaren, & Mulhall, 2007) to identify barriers and enablers (Grol, Wensing, & Eccles, 2005); identification of a clinical site champion (Flodgren et al., 2011); use of a standardised interactive education program (Forsetlund et al., 2009), (O'Brien et al., 2007); and use of reminders (Grimshaw J. M. et al., 2004). Following the workshops, sites were asked to address these barriers and self-nominate a date for commencing use of the FeSS protocols once barriers had been addressed. Nineteen acute stroke units in New South Wales (NSW) Australia participated, providing data from 1696 patients. Our results showed that patients cared for in stroke units who received implementation support were 15.7% more likely to be alive and independent 90-days following their stroke. They also had fewer episodes of fever, lower mean temperatures, lower mean blood glucose levels, and improved screening for swallowing difficulties (Middleton et al., 2009; Middleton et al., 2011).

In this paper, we report the perceived barriers and enablers identified by clinicians prior to implementation of the FeSS protocols. At the conclusion of the trial, we revisited these perceived pre-trial barriers to determine which, if any, were actual barriers as reported by the clinical site champions who also were our local trial contacts at our intervention sites. This information may be useful for clinicians seeking to implement similar protocols.

METHOD

A mixed method design was used comprising a qualitative phase using workshops to identify perceived barriers and enablers prior to implementation of the FeSS protocols, and a quantitative approach post-implementation using an on-line survey to elicit actual barriers and enablers to use of the FeSS protocols.

Pre-implementation identification of perceived barriers and enablers to Fess protocol uptake

Two interactive multidisciplinary workshops were conducted at each of the ten intervention stroke units. At both workshops, following presentations to clinicians regarding the QASC trial and the clinical protocols, the clinicians were asked two questions as follows: what are the perceived barriers and enablers to use of these protocols: i) within the stroke unit; and ii) at the hospital (organisational) level. Senior clinicians within the stroke team were invited to attend the first workshop, namely, the medical director, nurse unit manager, stroke unit co-ordinator, director of speech pathology. The second workshop was held with a convenience sample of multidisciplinary bedside clinicians and both were held at a time convenient to all. These workshops were conducted by SM, CL and SD, two to four weeks apart and approximately six weeks prior to implementation of the FeSS protocols.

Post-implementation actual barriers and enablers to Fess protocol uptake

An on-line survey was sent to the clinical site champion at each of the 10 QASC intervention stroke units in June 2011, six months post completion of the main QASC trial. Our survey included questions about respondent demographics (four questions) and specific questions derived directly from perceived barriers identified by clinicians at the QASC Trial pre-implementation workshops. These were grouped as follows: policy barriers (five questions), workforce barriers (six questions), equipment barriers (four questions) and education barriers (five questions). Next, participants were asked to list any additional actual barriers not previously identified (one question). Each survey item was rated on a five-point Likert scale ranging from ‘strongly agree’ to ‘strongly disagree’.

In addition, clinical site champions were asked whether they were still using each of the FeSS protocols ('Yes', 'No', 'Don't know/ Can't remember') and if they would recommend the FeSS protocols to other stroke units ('highly likely' to 'highly unlikely') whether the FeSS protocols empowered nursing staff to approach the multidisciplinary team about patient management ('strongly agree' to 'strongly disagree'); and if they would recommend the FeSS protocols for use in emergency departments ('Yes', 'No', 'Don't know/ Can't remember'). Respondents were also able to provide comments in this section.

Data Analysis

Participants responses from the pre-implementation workshops were transcribed into lists following the workshops and then were coded according to barriers, enablers and strategies to overcome barriers by one of the researchers. The coding frame was developed iteratively as two researchers reviewed the feedback. We undertook a content analysis grouping barriers, both at the stroke unit level and the organisational level into relevant categories. Responses from the two workshops at each site were grouped together. Recurrent factors were noted and feedback excerpts were allocated to these codes. In addition, differences in the feedback between the sites were noted. Participant quotes were used to illustrate meaning in the main factors derived.

Frequencies from the post-implementation survey were determined. Each of the perceived barriers was defined as being an 'actual barrier' where greater than or equal to 50% of participants so agreed post-implementation.

Ethical approval to conduct the trial was obtained from the Human Research Ethics Committee of the Australian Catholic University and the relevant ethics committees of all 19 participating hospitals.

RESULTS

Pre-Implementation: Perceived Barriers

A total of 20 pre-implementation workshops were conducted (two at each of the 10 intervention stroke units). The number of participants per site ranged from 4 to 13 and the majority of the 111 clinicians that attended the workshops were nurses (n=70, 63%) (Table 1). Pre-implementation perceived barriers were centred on four categories: policy, workforce, equipment and education as outlined below (Table 2). The majority of barriers were uniform between sites with the equipment barriers differing in which equipement issues were barriers at each site.

Policy related barriers

There were three policy barriers related to the implementation of the FeSS protocols. The need for written orders from doctors for nurses to commence saline and/ or insulin according to the hyperglycaemic protocol was identified as a barrier, as was no previous use of insulin infusions.

> *'the doctors won't want to come up in the middle of the night to write up insulin'*

In addition, the requirement for nurses to obtain a written order for all but the first dose of paracetamol was also considered a likely barrier (Table 2). In all NSW hospitals, nursing staff were permitted by NSW Department of Health protocol to administer only the first dose of paracetamol without a written medical order.

Workforce related barriers

There were eight barriers identified related to workforce issues. Patient safety, largely associated with management of insulin infusions, was perceived to be a potential barrier.

> '*what happens when we have more than one patient with an insulin infusion, how can we maintain patient safety*'

Finding a member of staff to re-cannulate patients after hours was identified as a possible workforce barrier, as was the shortage of speech pathologists to train nurses to perform and access swallow screens (Table 2). Increased workload was a concern with particular reference to the possible need for hourly blood glucose monitoring for glycaemically unstable patients. There was also concern that there could be a resulting insufficient number of staff to safely look after more than one patient requiring an insulin infusion. Patients with insulin infusions require a nurse escort should they need to leave the stroke unit for any tests (e.g. imaging) and this then could leave the stroke unit short staffed. Endorsed enrolled nurses' (enrolled nurses in Australia obtain a one year diploma of enrolled nursing from a Technical And Further Education College; endorsed enrolled nurses can also administer some medications) inability to administer insulin was identified as a factor potentially increasing the workload of the registered nurse.

In addition, on some stroke units where use of casual nursing staff occurred, the transient nature of their employment was seen as possibly increasing the work load of the regular stroke unit nurses as casual nursing staff may not have undergone any local education or necessarily be aware of the FeSS protocols.

Equipment related barriers

Equipment barriers were identified with concerns about lack of thermometers, blood glucose monitors, fluid pumps, and syringe drivers on the stroke units (Table 2).

'what if we are unable to get a fluid pump from the hospital supply'

Education related barriers

Seven barriers were identified relating to education. The logistics of training all the clinical staff including those who worked only weekend shifts and night duty was highlighted. Since our swallowing management protocol consisted of nurses being trained to undertake swallowing screening (previously the remit solely of speech pathologists) clinicians were concerned that this would result in reluctance of nursing staff to undertake the screening role and training required to use the Acute Screening of swallow in Stroke / TIA (ASSIST) tool (Table 2). Some concern also was expressed about the possibility of poor levels of engagement with both doctors and speech pathologists associated with the changed work practices.

The speechies won't be happy we are taking over their jobs!'

The issue of medical staff not being aware of the trial was also raised. Other barriers specific to swallow management included concern about the time needed to undergo swallow screen education and reluctance on behalf of the medical teams to use the ASSIST tool (Table 2).

Pre-Implementation: Enablers

Enablers identified during the workshops fell into the two main categories of organisational support and integration of the FeSS protocols into routine care. Enablers' related to organisational support included the concept of having champions for the trial, having the

support of the other neurologists (in addition to Stroke Unit Director) and having the support of the senior staff (e.g. Director of Allied Health).

Enablers related to integration of the FeSS protocols into care were: nurses' ability to adapt their own local care plans and policies to reflect the FeSS protocols; being able to augment implementation with the use of local strategies (i.e. laminating the protocols and placing them at the bedside as suggested by one site); and having staff that were always allocated to the stroke unit (Box 2).

Post-Implementation: Actual Barriers

All clinical site champions from our ten intervention stroke units participated in our online post-implementation survey (100% response rate), the majority of whom were clinical nursing consultants (n=7, 70%) (Table 1). All also had attended the pre-implementation workshops. Only five of the 22 perceived barriers identified pre-implementation were listed as actual barriers and are outlined below using the same categories from the pre-implementation survey (Table 2).

Policy related barriers

In relation to hospital policy, only two of the perceived barriers: no previous use of insulin infusions (n=6, 60% 'agreed' or 'strongly agreed'); and requiring written orders for the insulin infusions (n=5%, 50% 'agreed' or 'strongly agreed') were considered to be actual barriers post-implementation. Participants no longer considered the requirement for written orders for paracetamol beyond the first dose to be an actual barrier (n=3, 30% 'agreed' or 'strongly agreed') (Table 2).

Workforce related barriers

There were no workforce related pre-implementation barriers that were found to be actual post-implementation barriers. Only 10% (n=1) of participants 'agreed' or 'strongly agreed' that increased workload had been an actual barrier. The issue of high numbers of casual staff working on the stroke unit was not considered an actual barrier (n=2, 20% 'agreed' or 'strongly agreed'). Examination of workforce barriers showed that less than half of the participants considered finding staff to re-cannulate patients after hours as a barrier (n=4, 40%. agreed' or 'strongly agreed') and only 20% (n=2) 'agreed' or 'strongly agreed' that not enough nurses to carry out hourly observations was a barrier. When looking specifically at workforce barriers related to the swallow protocol, only one person (n=1, 10%) 'agreed' or 'strongly agreed' insufficient numbers of speech pathologists to carry out the education was an actual barrier. With regard to the sugar protocol, 10% (n=1) 'agreed' or 'strongly agreed' that insufficient staff to safely look after more than one patient on an insulin infusion was a barrier.

Equipment related barriers

Lack of equipment was not considered to be an actual barrier by participants. Specifically, 10% (n=1) 'agreed' or 'strongly agreed' lack of thermometers was an actual barrier; 30% (n=3) 'agreed' or 'strongly agreed' lack of syringe drivers was an actual barrier' (Table 2).

Education related barriers

Three educational barriers identified pre-implementation that were found to be actual barriers post-implementation. Medical staff not being aware of the trial and related protocols (n=5, 50% 'agreed' or 'strongly agreed'); poor level of engagement of the medical staff (n=5, 50% 'agreed' or 'strongly agreed'); and medical staff reluctance to use the ASSIST tool (n=8, 80%

'agreed' or 'strongly agreed') were considered to be actual barriers (Table 2). Less than half of participants (n=4, 40%) 'agreed' or 'strongly agreed' that the time needed by nurses to undergo training and competency assessment by speech pathologists was an actual barrier. Poor levels of engagement by speech pathology staff was not considered to have been an actual barrier (n=0, 0% 'agreed' or 'strongly agreed') (Table 2).

On-going use of FeSS protocols

Over three quarters of participants (n=7) were currently using the FeSS protocols on their unit, with all respondents currently using the swallowing element of the FeSS protocol (n=10, 100%). In addition, 90% of participants (n=9) recommended that the FeSS protocols be used in the emergency department, and would be 'highly likely' or 'likely' to recommend the FeSS protocols to other stroke units. Over half of all participants 'strongly agree' or 'agree' that the three elements (fever: n=6, 60%; sugar: n=7, 70%; swallowing: n=9, 90%) of the FeSS protocols empowered nursing staff to approach the multi-disciplinary team regarding patients management (Table 3). Overall, open-ended responses gathered from the participants indicated underlying challenges with medical teams in engaging with the adoption and use of the FeSS protocols at the local level:

> *"The challenge was with rotating medical staff who were not aware or did not want to become aware of the protocols"*

Participants also identified that initial uptake of the FeSS protocols required ongoing support, monitoring and education in order for them to become part of everyday practice:

"Implementation of the protocols required strong leadership and constant monitoring to ensure the processes became daily business"

'Nurses require continual education on the protocols so they remember to implement these protocols'

DISCUSSION

This paper outlines results of our barrier assessment prior to and following pre-planned implementation of new evidence-based clinical protocols for acute stroke management. Barrier assessment has been shown to be a crucial step in successful implementation of evidence to practice (Grol et al., 2003; Hamilton et al., 2007; Scott et al., 2009). Our approach is novel, in that, at the end of the trial, we re-examined the perceived barriers identified pre-implementation to determine which, if any, had been actual barriers to protocol uptake. This study was limited by the small sample size in the post-implementation survey which included only clinical site champions . However the role of the clinical site champion was instrumental to the implementation of the FeSS protocols and we believe their ongoing engagement with the study at all stages gives a valid and reliable representation of key barriers and enablers. The QASC trial pre-implementation perceived barriers and actual barriers fell into four main categories; policy, workforce, education and equipment.

While all of three protocols required new ways of working within the intervention stroke units, it was the fever and sugar protocols that were identified pre-intervention as potential to experience barriers from a policy perspective. Indeed, in relation to the sugar protocol, the use of insulin infusions as a new procedure was found post-intervention to have been an actual barrier to implementation. In relation to the fever protocol, it is important to note that

in the QASC trial settings, nurses from all intervention units were permitted by a Department of Health policy to administer the first dose of oral paracetamol for fever without a pre-signed written medical order and, hence, rapid administration of an initial paracetamol dose by a nurse for fever was not perceived as a pre-intervention barrier in our setting. However, this may be a barrier in other jurisdictions or hospitals where such practices may not be policy. Second and subsequent administration of paracetamol was not an actual barrier.

Eight workforce related perceived barriers were identified pre-intervention across the three elements of the intervention. The use of insulin infusions and the pre-implementation concern that this might result in extra observations being required was considered to be a potential impact upon protocol adoption. This was not unexpected as work overload and inadequate staffing have been seen to be a barrier in other studies (Hamilton et al., 2007). However, of interest, our post-implementation survey did not find any of the workforce concerns to be actual barriers to uptake of the protocols.

None of the equipment perceived barriers identified pre-intervention were found to be actual barriers. It is important to recognise that some perceived barriers that were identified in the pre-implementation workshop were successfully addressed prior to the trial commencement (i.e. lack of equipment) and indeed, this is the purpose of undertaking a barrier assessment. It is likely this is why lack of equipment was not perceived as an actual barrier and encouraging that nurses were able to overcome this obstacle with no additional resources provided by the trial for this purpose.

Our findings also demonstrated that a number of educational perceived barriers related to the implementation of the FeSS protocols directly involved medical staff, in particular the

continuous engagement of the doctors. Future nurse-led and multidisciplinary studies in this area should aim to address issues surrounding the local engagement of medical staff. This is an issue that has been identified in a number of previous studies investigating patient safety and quality initiatives (Gollop, Whitby, Buchanan, & Ketley, 2004) but can be difficult to achieve over the life of a trial such as ours (that ran for five years) due to frequent junior medical staff rotations.

The importance of teamwork has been documented in the literature, particularly in stroke, (Baxter & Brumfitt, 2008; Indredavik, Bakke, Slordahl, Rokseth, & Haheim, 1999; Stroke Unit Trialists' Collaboration, 2007) and this was a key element of our trial, and addressed by inclusion of all relevant disciplines in the workshops. This was also emphasised by the enablers that the staff identified, in particular, the importance of clinical site champions and supportive management. Such findings are supported by the Cochrane review examining opinion leaders (Flodgren et al., 2007) which found that the use of opinion leaders can help evidence-based practice by promoting the evidence and bridging the evidence-practice gap.

Our results show that not all perceived barriers eventuate as actual barriers. There are a number of instances where this is reflected (e.g. potential increased workload, equipment supplies and paracetamol administration policies). As previously mentioned, this could be a result of the barriers being successful addressed throughout the trial (i.e. purchasing of new equipment) or the willingness of the particular staff to actively address issues. However, pre-intervention identification of perceived ‘non-barriers’ may also reflect over-cautiousness by staff. Examination of perceived and subsequent actual barriers to evidence implementation presents a number of challenges due to the paucity of high quality process evaluations (Drury

P et al., 2013) undertaken alongside these kinds of clinician practice change trials,(Grant, Treweek, Dreischulte, Foy, & Guthrie, 2013) and as such, our trial is significant because it presents a novel perspective. This is an area where future study is warranted to better guide similar implementation studies and, in particular, to expunge pre-conceived attitudes to changing clinician behaviour.

CONCLUSION

Perceived barriers to the implementation of new protocols may not always eventuate as actual barriers. Nonetheless, identification of perceived barriers and enablers prior to an implementation strategy to enhance evidence-based clinical practice is especially valuable in a multidisciplinary context. An opportunity for staff to identify, plan for and overcome barriers is a critical part of maximising clinical practice change. In turn, this promotes clinician ownership over quality improvement initiatives and may accelerate successful implementation and translation of evidence into practice. Ours is one of the few studies to compare the perceived barriers identified pre-implementation with actual barriers that were encountered. This valuable process could assist with introduction of new interventions by helping to convince clinicians that not all barriers will eventuate.

Box: Linking Evidence to Action

- Identification of barriers to practice change has been shown to improve evidence uptake
- However, perceived barriers identified pre-implementation may not always turn out to be actual barriers
- Education and engagement of the multi-disciplinary team supports successful implementation of relevant clinician behaviour change interventions
- Local opinion leaders can assist in promoting and implementing evidence-based interventions

Box 2 Pre-implementation enablers (n=6)

Organisational support:

- Having clinical site champions for the trial
- The support of neurologists in addition to the Stroke Unit Director
- The support of senior staff

Integration of the FeSS clinical treatment protocols into care:

- Nurses ability to adapt local care plans
- Being able to augment implementation with local strategies
- Having staff exclusively allocated to the stroke unit

Table 1: Clinical designations of workshop attendees (pre and post-implementation)

Designation	**Pre-implementation (n=111) n (%)**	**Post-implementation (n=10) n (%)**
Nurses		
Registered Nurse	32 (29)	0 (0)
Clinical Nurse Consultant	13 (12)	7 (70)
Nurse Unit Manager	11 (10)	0 (0)
Endorsed Enrolled Nurse	7 (6.3)	0 (0)
Clinical Nurse Specialist	5 (4.5)	0 (0)
Stroke Liaison Nurse	1 (0.9)	1 (10)
Enrolled Nurse	1 (0.9)	0 (0)
Clinical Nurse Educator	0 (0)	2 (20)
Allied Health		
Speech Pathologist	14 (13)	0 (0)
Physiotherapists	3 (2.7)	0 (0)
Stroke Unit Coordinator	1 (0.9)	0 (0)
Medical	15 (14)	0 (0)
Other	2 (1.8)	0 (0)

Table 2: Perceived barriers identified pre-implementation and results of post-implementation survey (n=22)

Perceived barriers identified pre-implementation	**Post-implementation survey results**				
	Strongly Agree n (%)	**Agree n (%)**	**Neither agree or disagree n (%)**	**Disagree n (%)**	**Strongly Disagree n (%)**
Policy barriers to the FeSS protocols					
Fever					
Inability to administer more than first dose of paracetamol without a written order	0(0.0)	3(30.0)	3(30.0)	2(20.0)	2(20.0)
Sugar					
Insulin infusions not previously allowed on stroke unit	**4(40.0)**	**2(20.0)**	**1(10.0)**	**1(10.0)**	**2(20.0)**
Hyperglycaemic protocols could not be commenced without a written order	**2(20.0)**	**3(30.0)**	**1(10.0)**	**3(30.0)**	**0(0.0)**
Workforce barriers to the FeSS protocols					
Sugar					
Insufficient staff to safely look after more than one insulin infusion patient.	1(10.0)	0(0.0)	6(60.0)	1(10.0)	1(10.0)
Endorsed Enrolled Nurses are not accredited to adjust insulin infusions or to test BGLs	1(10.0)	2(20.0)	3(30.0)	3(30.0)	1(10.0)
Patients with insulin infusions requiring a nurse escort to leave the stroke unit	1(10.0)	0(0.0)	5(50.0)	2(20.0)	2(20.0)
Not enough nurses to do hourly observations	1(10.0)	1(10.0)	2(20.0)	4(40.0)	2(20.0)
Swallow					
Insufficient speech pathology staff to train and assess nurses in performing swallow screens	0(0.0)	1(10.0)	2(20.0)	3(30.0)	4(40.0)
Generic					
High number of agency staff on the stroke unit	1(10.0)	1(10.0)	1(10.0)	5(50.0)	2(20.0)
Finding a staff member to re-cannulate out of hours	1(10.0)	3(30.0)	1(10.0)	3(30.0)	2(20.0)
Potential increase in nursing workload	0(0.0)	1(10.0)	6(60.0)	2(20.0)	1(10.0)
Equipment barriers to the FeSS protocols					
Fever					
Not enough thermometers on the stroke unit	0(0.0)	1(10.0)	2(20.0)	3(30.0)	4(40.0)
Sugar					
Not enough syringe drivers on the stroke unit	1(10.0)	2(20.0)	1(0.0)	5(50.0)	1(10.0)
Not enough blood glucose monitors on the stroke unit	0(0.0)	0(0.0)	3(20.0)	6(60.0)	1(10.0)
Not enough fluid pumps on the stroke unit	0(0.0)	0(0.0)	2(10.0)	7(70.0)	1(10.0)
Education barriers to the FeSS protocols					
Swallow					
Time needed to undergo swallowing education	2(20.0)	2(20.0)	2(20.0)	3(30.0)	1(10.0)
Medical staff reluctance to use the formal ASSIST tool	**2(20.0)**	**6(60.0)**	**1(10.0)**	**0(0.0)**	**1(10.0)**
Reluctance of nursing staff to undertake screening role	0 (0.0)	1 (10.0)	2 (20.0)	5 (50.0)	2 (20.0)
Generic					
Poor level of engagement with speech pathology staff	(0.0)	0(0.0)	1(10.0)	1(10.0)	8(80.0)
Poor level of engagement of medical staff	**1(10.0)**	**4(40.0)**	**1(10.0)**	**4(40.0)**	**0(0.0)**
Doctors not aware of trial	**1(10.0)**	**4(40.0)**	**2(20.0)**	**3(30.0)**	**0(0.0)**
Feasibility of educating night duty staff	1(10.0)	3(30.0)	2(20.0)	4(40.0)	0(0.0)

* Bolded items are those considered to be actual barriers *both* pre- and post-implementation i.e. greater than 50% strongly agree or agree post-implementation

Table 3. Post-implementation additional questions (n=10)

	Yes n (%)	No n (%)	Don't Know / Can't remember n (%)
Current use of FeSS protocols:			
Fever	9 (90)	1 (10)	0 (0)
Sugar	7 (70)	3 (30)	0 (0)
Swallowing	10 (100)	0 (0)	0 (0)
Recommendation for use of FeSS protocols in the ED	9 (90)	1 (10)	0 (0)

	Highly Likely n (%)	Likely n (%)	Don't Know n (%)	Unlikely n (%)	Highly Unlikely n (%)	Don't Know / Can't remember n (%)
Likelihood of recommending FeSS protocols to other ASUs	6 (60)	3 (30)	0 (0)	0 (0)	1 (10)	0 (0)

	Strongly Agree n (%)	Agree n (%)	Neither Agree or Disagree n (%)	Disagree n (%)	Strongly Disagree n (%)	Don't Know / Can't remember n (%)
Agreement that the FeSS protocols empowered nursing staff to approach the MDT team about patient management:						
Fever	3 (30)	3 (30)	4 (40)	0 (0)	0 (0)	0 (0)
Sugar	3 (30)	4 (40)	2 (20)	1 (10)	0 (0)	0 (0)
Swallowing	3 (30)	6 (60)	1 (10)	0 (0)	0 (0)	0 (0)

References

Adams, H. P., Jr., del Zoppo, G., Alberts, M. J., Bhatt, D. L., Brass, L., Furlan, A., . . . Wijdicks, E. F. M. (2007). Guidelines for the Early Management of Adults With Ischemic Stroke: A Guideline From the American Heart Association/ American Stroke Association Stroke Council, Clinical Cardiology Council, Cardiovascular Radiology and Intervention Council, and the Atherosclerotic Peripheral Vascular Disease and Quality of Care Outcomes in Research Interdisciplinary Working Groups: . *Stroke, 38*(5), 1655-1711. doi: 10.1161/strokeaha.107.181486

Allport, L. E., Baird, T., Butcher, K., Macgregor, L., Prosser, J., Colman, P., & Davis, S. (2006). Frequency and temporal profile of poststroke hyperglycemia using continuous glucose monitoring. *Diabetes Care, 29*(8), 1839-1844.

Allport, L. E., Baird, T. A., & Davis, S. M. (2008). Hyperglycaemia and the ischaemic brain: continuous glucose monitoring and implications for therapy. *Current Diabetes Reviews, 4*(3), 245-257.

Azzimondi, G., Bassein, L., Nonino, F., Fiorani, L., Vignatelli, L., Re, G., & D'Alessandro, R. (1995). Fever in acute stroke worsens prognosis. A prospective study. *Stroke, 26*(11), 2040-2043.

Baxter, S. K., & Brumfitt, S. M. (2008). Once a week is not enough: evaluating current measures of teamworking in stroke. *Journal of Evaluation in Clinical Practice, 14*(2), 241-247.

Boysen, G., & Christensen, H. (2001). Stroke severity determines body temperature in acute stroke. *Stroke, 32*(2), 413-417.

Busto, R., Globus, M. Y., Dietrich, W. D., Martinez, E., Valdes, I., & Ginsberg, M. D. (1989). Effect of mild hypothermia on ischemia-induced release of neurotransmitters and free fatty acids in rat brain. *Stroke, 20*(7), 904-910.

Castillo, J., Davalos, A., Marrugat, J., & Noya, M. (1998). Timing for Fever-Related Brain Damage in Acute Ischemic Stroke. *Stroke, 29*(12), 2455-2460.

Doggett, D. L., Tappe, K. A., Mitchell, M. D., Chapell, R., Coates, V., & Turkelson, C. M. (2001). Prevention of pneumonia in elderly stroke patients by systematic diagnosis and treatment of dysphagia: an evidence-based comprehensive analysis of the literature. *Dysphagia, 16*(4), 279-295.

Drury P, Levi C, D'Este C, McElduff P, McInnes E, Hardy J, . . . Middleton S. (2013). Quality in Acute Stroke Care (QASC): Process evaluation of an intervention to improve the management of fever, hyperglycaemia and swallowing dysfunction following acute stroke. *International Journal of Stroke, In press, accepted August 2013.*

European Stroke Organisation (ESO) Executive Committee, & ESO Writing Committee. (2008). Guidelines for management of ischaemic stroke and transient ischaemic attack 2008. *Cerebrovascular Diseases, 25*(5), 457-507.

Flodgren, G., Parmelli, E., Doumit, G., Gattellari, M., O'Brien, M. A., Grimshaw, J., & Eccles, M. P. (2011). Local opinion leaders: effects on professional practice and health care outcomes. *Cochrane Database of Systematic Reviews*(8), CD000125. doi: http://dx.doi.org/10.1002/14651858.CD000125.pub4

Flodgren, G., Parmelli, E., Doumit, G., Gattellari, M., O'Brien Mary, A., Grimshaw, J., & Eccles Martin, P. (2007). Local opinion leaders: effects on professional practice and health care outcomes. *Cochrane Database of Systematic Reviews,* (1). http://www.mrw.interscience.wiley.com/cochrane/clsysrev/articles/CD000125/frame.html doi:10.1002/14651858.CD000125.pub3

Forsetlund, L., Bjorndal, A., Rashidian, A., Jamtvedt, G., O'Brien, M. A., Wolf, F., . . . Oxman, A. D. (2009). Continuing education meetings and workshops: effects on professional practice and health care outcomes. *Cochrane Database of Systematic Reviews*(2).

Ginsberg, M. D., & Busto, R. (1998). Combating hyperthermia in acute stroke: a significant clinical concern. *Stroke, 29*(2), 529-534.

Gollop, R., Whitby, E., Buchanan, D., & Ketley, D. (2004). Influencing sceptical staff to become supporters of service improvement: a qualitative study of doctors' and managers' views. *Quality & Safety in Health Care, 13*(2), 108-114.

Grant, A., Treweek, S., Dreischulte, T., Foy, R., & Guthrie, B. (2013). Process evaluations for cluster-randomised trials of complex interventions: a proposed framework for design and reporting. *Trials [Electronic Resource], 14*(15).

Greer, D. M., Funk, S. E., Reaven, N. L., Ouzounelli, M., & Uman, G. C. (2008). Impact of fever on outcome in patients with stroke and neurologic injury: a comprehensive meta-analysis. *Stroke, 39*(11), 3029-3035.

Grimshaw, J., Eccles, M., & Tetroe, J. (2004). Implementing clinical guidelines: current evidence and future implications. *Journal of Continuing Education in the Health Professions, 24 Suppl 1*.

Grimshaw, J. M., Thomas, R. E., MacLennan, G., Fraser, C., Ramsay, C. R., Vale, L., . . . Donaldson, C. (2004). Effectiveness and efficiency of guideline dissemination and implementation strategies. *Health Technology Assessment, 8*(6), 1-72.

Grol, R., & Grimshaw, J. (2003). From best evidence to best practice: effective implementation of change in patients' care. *Lancet, 362*(9391), 1225-1230.

Grol, R., Wensing, M., & Eccles, M. (2005). Implementation of Changes in Practice *Improving Patient Care. The Implementation of Change in Clinical Practice* (pp. 6-15). Edinburgh: Elsevier

Hamilton, S., McLaren, S., & Mulhall, A. (2007). Assessing organisational readiness for change: use of diagnostic analysis prior to the implementation of a multidisciplinary assessment for acute stroke care. *Implementation Science, 2*(1), 21.

Indredavik, B., Bakke, F., Slordahl, S. A., Rokseth, R., & Haheim, L. L. (1999). Treatment in a combined acute and rehabilitation stroke unit: which aspects are most important? *Stroke, 30*(5), 917-923.

Managers of Great Metropolitan Speech Pathology Services in NSW Health. (2004). Stroke Dysphagia Framework. Sydney.

Martino, R., Foley, N., Bhogal, S., Diamant, N., Speechley, M., & Teasell, R. (2005). Dysphagia After Stroke: Incidence, Diagnosis, and Pulmonary Complications. *Stroke, 36*(12), 2756-2763. doi: 10.1161/01.STR.0000190056.76543.eb

Middleton, S., Levi, C., Ward, J., Grimshaw, J., Griffiths, R., D'Este, C., . . . Cadilhac, D. (2009). Fever, hyperglycaemia and swallowing dysfunction management in acute stroke: A cluster randomised controlled trial of knowledge transfer. *Implementation Science, 4*(1), 16.

Middleton, S., McElduff, P., Ward, J., Grimshaw, J. M., Dale, S., D'Este, C., . . . C, L. (2011). Implementation of evidence-based treatment protocols to manage fever, hyperglycaemia, and swallowing dysfunction in acute stroke (QASC): a cluster randomised controlled trial. *The Lancet, 378* (9804), 1699-1706.

Morris, Z. S., Wooding, S., & Grant, J. (2011). The answer is 17 years, what is the question: understanding time lags in translational research. *Journal of the Royal Society of Medicine, 104*(12), 510-520. doi: http://dx.doi.org/10.1258/jrsm.2011.110180

National Institute for Health and Clinical Excellence. (2008). Diagnosis and Initial Management of Acute Stroke and Transient Ischemic Attack (TIA). London.

National Stroke Foundation. (2007). Clinical Guidelines for Acute Stroke Managment. Victoria: NSF

National Stroke Foundation. (2010). Clinical Guidelines for Stroke Management 2010. Victoria: NSF.

O'Brien, M.-A., Rogers, S., Jamtvedt, G., Oxman Andrew, D., Odgaard-Jensen, J., Kristoffersen Doris, T., . . . Harvey, E. (2007). Educational outreach visits: effects on professional practice and health care outcomes. *Cochrane Database of Systematic Reviews*, (4). doi:10.1002/14651858.CD000409.pub2

Pulsinelli, W. A., Levy, D. E., Sigsbee, B., Scherer, P., & Plum, F. (1983). Increased damage after ischemic stroke in patients with hyperglycemia with or without established diabetes mellitus. *American Journal of Medicine, 74*(4), 540.

Scott, J., Robinson, G. M., French, J. M., O'Connell, J. E., Alberti, K. G. M. M., & Gray, C. S. (1999). Prevalence of admission hyperglycaemia across clinical subtypes of acute stroke. *Lancet, 353*, 376-377.

Scott, S., Osmond, M., O'Leary, K., Graham, I., Grimshaw, J., Klassen, T., & Group, t. P. E. R. C. M. s. S. (2009). Barriers and supports to implementation of MDI/spacer use in nine Canadian pediatric emergency departments: a qualitative study. *Implementation Science, 4*(1), 65.

Stroke Unit Trialists' Collaboration. (2007). Organised inpatient (stroke unit) care for stroke. *Cochrane Database of Systematic Reviews*(4).

Wang, Y., Lim, L. L., Levi, C., Heller, R. F., & Fisher, J. (2000). Influence of admission body temperature on stroke mortality. *Stroke, 31*(2), 404-409.

Weir, C. J., Murray, G. D., Dyker, A. G., & Lees, K. R. (1997). Is hyperglycaemia an independent predictor of poor outcome after acute stroke? Results of a long term follow up study. *British Medical Journal, 314*(7090), 1303.

Williams, L. S., Rotich, J., Fineberg, N., Espay, A., Bruno, A., Fineberg, S., & Tierney, W. (2002). Effects of admission hyperglycemia on mortality and costs in acute ischemic stroke. *Neurology, 59*(1), 67-71.