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Interventions for the uptake of evidence-based recommendations in acute stroke settings (Review)

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[Intervention Review]

Interventions for the uptake of evidence-based recommendations in acute stroke settings

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ABSTRACT

Background

There is a growing body of research evidence to guide acute stroke care. Receiving care in a stroke unit improves access to recommended evidence-based therapies and patient outcomes. However, even in stroke units, evidence-based recommendations are inconsistently delivered by healthcare workers to patients with stroke. Implementation interventions are strategies designed to improve the delivery of evidence-based care.

Objectives

To assess the effects of implementation interventions (compared to no intervention or another implementation intervention) on adherence to evidence-based recommendations by health professionals working in acute stroke units. Secondary objectives were to assess factors that may modify the effect of these interventions, and to determine if single or multifaceted strategies are more effective in increasing adherence with evidence-based recommendations.

Search methods

We searched CENTRAL, MEDLINE, Embase, CINAHL, Joanna Briggs Institute and ProQuest databases to 13 April 2022. We searched the grey literature and trial registries and reviewed reference lists of all included studies, relevant systematic reviews and primary studies; contacted corresponding authors of relevant studies and conducted forward citation searching of the included studies. There were no restrictions on language and publication date.

Selection criteria

We included randomised trials and cluster-randomised trials.

Participants were health professionals providing care to patients in acute stroke units; implementation interventions (i.e. strategies to improve delivery of evidence-based care) were compared to no intervention or another implementation intervention. We included studies only if they reported on our primary outcome which was quality of care, as measured by adherence to evidence-based recommendations, in order to address the review aim.

Data collection and analysis

Two review authors independently selected studies for inclusion, extracted data and assessed risk of bias and certainty of evidence using GRADE. We compared single implementation interventions to no intervention, multifaceted implementation interventions to no intervention, multifaceted implementation interventions compared to single implementation interventions and multifaceted implementation interventions to another multifaceted intervention. Our primary outcome was adherence to evidence-based recommendations.

Main results

We included seven cluster-randomised trials with 42,489 patient participants from 129 hospitals, conducted in Australia, the UK, China, and the Netherlands. Health professional participants (numbers not specified) included nursing, medical and allied health professionals. Interventions in all studies included implementation strategies targeting healthcare workers; three studies included delivery arrangements, no studies used financial arrangements or governance arrangements. Five trials compared a multifaceted implementation intervention to no intervention, two trials compared one multifaceted implementation intervention to another multifaceted implementation intervention. No included studies compared a single implementation intervention to no intervention or to a multifaceted implementation intervention. Quality of care outcomes (proportions of patients receiving evidence-based care) were included in all included studies. All studies had low risks of selection bias and reporting bias, but high risk of performance bias. Three studies had high risks of bias from non-blinding of outcome assessors or due to analyses used.

We are uncertain whether a multifaceted implementation intervention leads to any change in adherence to evidence-based recommendations compared with no intervention (risk ratio (RR) 1.73; 95% confidence interval (CI) 0.83 to 3.61; 4 trials; 76 clusters; 2144 participants, I^2 =92%, very low-certainty evidence). Looking at two specific processes of care, multifaceted implementation interventions compared to no intervention probably lead to little or no difference in the proportion of patients with ischaemic stroke who received thrombolysis (RR 1.14, 95% CI 0.94 to 1.37, 2 trials; 32 clusters; 1228 participants, moderate-certainty evidence), but probably do increase the proportion of patients who receive a swallow screen within 24 hours of admission (RR 6.76, 95% CI 4.44 to 10.76; 1 trial; 19 clusters; 1,804 participants; moderate-certainty evidence). Multifaceted implementation interventions probably make little or no difference in reducing the risk of death, disability or dependency compared to no intervention (RR 0.93, 95% CI 0.85 to 1.02; 3 trials; 51 clusters ; 1228 participants; moderate-certainty evidence), and probably make little or no difference to hospital length of stay compared with no intervention (difference in absolute change 1.5 days; 95% CI -0.5 to 3.5; 1 trial; 19 clusters; 1804 participants; moderate-certainty evidence). We do not know if a multifaceted implementation intervention compared to no intervention result in changes to resource use or health professionals' knowledge because no included studies collected these outcomes.

Authors' conclusions

We are uncertain whether a multifaceted implementation intervention compared to no intervention improves adherence to evidence-based recommendations in acute stroke settings, because the certainty of evidence is very low.

PLAIN LANGUAGE SUMMARY

Interventions for the uptake of evidence-based recommendations in acute stroke settings

Do implementation interventions improve the delivery of evidence-based care in acute stroke units?

Key messages

Implementation interventions are designed to improve the delivery of 'evidence-based' care, which is care that has been proven in research studies to help people with a particular health condition. We do not know if implementation interventions delivered in acute stroke units lead to better delivery of evidence-based care.

More research is needed to investigate how to successfully implement evidence-based care in acute stroke settings. Future research should better describe the interventions and use consistent ways of measuring outcomes.

What did we want to find out?

We wanted to find out whether there are implementation interventions we can deliver in acute stroke settings to make sure that every patient on a stroke unit receives ‘evidence-based’ care. We were interested to look at ways to change healthcare workers' behaviour, as well as systems within hospitals, to understand what was most helpful in bringing about changes, so patients receive the best quality care.

What did we do?

We searched for research studies that were conducted in acute stroke units, where researchers compared interventions aimed at improving evidence-based care with no intervention, or different types of implementation interventions. We compared and summarised their results, and rated our confidence in the evidence, based on factors such as study methods and sizes.

What did we find?

We included seven studies that involved 42,489 acute stroke patients and an unknown number of health professionals. The studies were conducted in 129 hospitals in Australia, the UK, China and the Netherlands. The smallest study had 64 patients and the biggest study had 22,384 patients. Across the studies, over 85% of patients had ischaemic strokes, between 50% to 63% of patients were male, and their average age was between 65 tand78 years old.

Five studies compared a strategy made up of many parts (multifaceted) to no intervention and two studies compared one multifaceted strategy to another multifaceted strategy. Strategies in all studies aimed to change the behaviour of hospital staff and three studies looked at changing systems in the hospital.

We do not know if implementation strategies compared with no intervention have any effect on whether patients receive evidence-based care during their stroke unit admission. We think implementation strategies probably do not make a difference in the numbers of patients who are treated with thrombolysis (the "clot-buster" medicine), but probably do improve the number of patients who receive a swallow screen when they are first admitted to hospital. Implementation interventions compared to no intervention probably have little or no effect on the risk of patients dying or being disabled or dependent, and probably do not change how long patients stay in hospital. No studies reported economic costs or health professional knowledge.

What are the limitations of the evidence?

We are not confident in the evidence on whether patients receive evidence-based care during their stroke unit admission, because people collecting the data were aware of which patients received the interventions, the studies found very different results and there are not enough studies to be certain about the results. We are moderately confident in the evidence for the number of patients treated with thrombolysis, number of patients who receive a swallow screen, risk of patient dying or being disabled or dependent, and how long patients stay in hospital, mainly due to there not being enough studies for us to be certain.

This evidence is only relevant to acute stroke unit settings. Given that acute stroke units are expensive to set up and maintain, the evidence in this review is limited to well-funded healthcare facilities that have acute stroke units.

How up to date is this evidence?

This review includes papers that we identified from searching in April 2022.

SUMMARY OF FINDINGS

Summary of findings 1. Summary of findings

Multifaceted intervention compared with no intervention for uptake of evidence-based recommendations in acute stroke care

Patient or population: health professionals providing care to patients with stroke

Settings: acute stroke units

Intervention: multifaceted intervention to improve uptake of evidence-based recommendations

Comparison: no intervention

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Certainty of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	No intervention	Multifaceted intervention				
Quality of care: adherence to evidence-based recommendations during hospital admission	123 per 1000[a]	204 per 1000 (95% CI 129 to 269)	RR 1.73 (95% CI 0.83 to 3.61)	n = 2144 (4 trials)	⊕⊖⊖⊖ **very low**[b]	We are uncertain whether a multifaceted implementation intervention leads to any change in adherence to evidence-based recommendations compared with no intervention. Different evidence-based recommendations reported: 2 trials reported thrombolysis, 2 trials reported different bundles of care
Quality of care: proportion of patients with ischaemic stroke who receive thrombolysis (first 24 hours of admission)	150 per 1000[c]	169 per 1000 (95% CI 152 to 179)	RR 1.14 (95% CI 0.94 to 1.37)	n = 1228 (2 trials)	⊕⊕⊕⊖ **moderate**[d]	A multifaceted implementation intervention probably leads to little or no difference in the proportion of patients with ischaemic stroke who receive thrombolysis compared with no intervention.
Quality of care: proportion of patients who receive a swallow screen within 24 hours of admission	70 per 1000	460 per 1000[e]	RR 6.76 (95% CI 4.44 to 10.76)	n = 1804 (1 trial)	⊕⊕⊕⊖ **moderate**[f]	A multifaceted implementation intervention probably increases the proportion of patients who receive swallow screen compared with no intervention.

Patient outcome: death, disability or dependency at 90 days	586 per 1000[g]	504 per 1000 (95% CI 512 to 583)	RR 0.93 (95% CI 0.85 to 1.02)	n=1228 (3 trials)	⊕⊕⊕⊖ **moderate**[h]	A multifaceted implementation intervention probably leads to little or no difference in reducing the risk of poor patient outcomes (death, disability or dependency) at 90 d compared with no intervention. 3 studies reported death or disability using modified Rankin Scale, but different cut-off score used in 1 trial.
Hospital length of stay	13.7 d	11.3 d	Difference in absolute change 1.5 d (95% CI −0.5 to 3.5)	n = 1804 (1 trial)	⊕⊕⊕⊖ **moderate**[i]	A multifaceted implementation intervention probably leads to little or no difference in hospital length of stay compared with no intervention.
Resource use or economic outcomes during hospital stay			No studies reported this outcome.			
Health professional knowledge at 90 d			No studies reported this outcome.			

CI: confidence interval; **RR**: risk ratio

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[a]Calculated from pooled estimates of control groups from Dirks 2011, Levi 2020, Middleton 2011 and Power 2014.
[b]Downgraded 3 levels due to serious risk of bias (high risk of detection bias in 2 studies), inconsistency (high, unexplained heterogeneity), imprecision (wide 95% CIs, crossing line of no effect)
[c]Calculated from pooled estimates of control groups from Dirks 2011 and Levi 2020
[d]Downgraded 1 level due to risk of bias (high risk of detection bias in 1 study)
[e]Unable to calculate accurate CIs using recommended methods from Cochrane handbook (Schunemann 2022) given very low assumed risk and high corresponding risk (calculated upper limit of CIs was smaller than corresponding risk)
[f]Downgraded 1 level due to imprecision (only 1 trial)
[g]Calculated from pooled estimates of control groups from Dirks 2011, Levi 2020 and Middleton 2011
[h]Downgraded 1 level due to indirectness (different cut-off scores of same outcome measure used)
[i]Downgraded 1 level due to serious imprecision (only 1 trial with wide 95% CI)

BACKGROUND

Despite research evidence and clinical practice guidelines to direct the clinical management of patients with acute stroke, significant evidence-practice gaps remain (Stroke Foundation 2021). This is concerning, because there is evidence that the relationship between getting more of the evidence-based treatments after an acute stroke has dose-response association with survival and health-related quality-of-life (Cadilhac 2016). Various attempts to reduce evidence-practice gaps for acute stroke have been researched, but we have lacked systematic review evidence of the implementation strategies that are most effective. Many of the evidence-based recommendations for acute stroke care have a number of interacting components, so meet the definition of complex clinical interventions (Craig 2008), which can present particular challenges for translation into clinical practice (Redfern 2006).

Strong evidence from previous Cochrane Reviews has supported the use of stroke unit care for improving patient outcomes (Langhorne 2020). Acute stroke units, defined as settings where organised inpatient care is provided to patients with acute stroke by a multidisciplinary team who specialise in stroke management (Langhorne 2020), present unique environments for knowledge translation due to their fast-paced, generally short-stay nature (usually 5 to 10 days), and coordinated multidisciplinary teamwork. Care provision within acute stroke units can be variable (Drury 2014; Melnychuk 2019), so efforts to optimise delivery of evidence-based care within this setting are important.

Interventions to promote the use of evidence-based recommendations must account for the nature of the desired change in practice, the specific features of the setting, the patients and professionals involved, and the resources and systems available to support implementation (Damschroder 2009; Francke 2008; Grol 2002). Implementation interventions are strategies that are designed to improve the delivery of evidence-based care and encompass delivery arrangements (how, when, where and by whom health care is delivered), financial arrangements, governance arrangements and implementation strategies (methods and techniques designed to bring about changes in healthcare organisations, the behaviour of healthcare professionals or the use of health services by healthcare recipients) (Effective Practice and Organisation of Care 2015). Interventions shown to improve uptake of evidence-based clinical practices in other settings, such as acute cardiac care (Ting 2007), or even in post-acute stroke settings (Cahill 2020; Menon 2009), may not be transferable to acute stroke units, given their highly specialised nature.

Description of the condition

Stroke has been defined by the World Health Organization (WHO) as a "neurological deficit of cerebrovascular cause that persists beyond 24 hours or is interrupted by death within 24 hours" (Aho 1980). More recently, use of the term has broadened towards a tissue-based definition, which includes evidence of infarct without symptoms (Sacco 2013). About 80% of strokes are ischaemic in nature (caused by interruption of the blood supply to a particular area in the brain), and the remaining 20% are haemorrhagic (mainly due to rupture of a vessel) (Sims 2010). Advances in stroke care over the past decades have led to reductions in age-standardised death rates globally, yet stroke remains a major cause of death and disability (GBD 2019 Stroke Collaborators). Approximately 37% of survivors have stroke-related disability that reduces their ability to carry out daily living activities unassisted (Deloitte Access Economics 2020).

Description of the intervention

This review focuses on implementation interventions, classified in the Cochrane Effective Practice and Organisation of Care (EPOC) taxonomy as delivery arrangements (e.g. coordination of care and management of care processes), financial arrangements, governance arrangements and implementation strategies (e.g. audit and feedback, education strategies, clinical practice guidelines, continuous quality improvement) (Effective Practice and Organisation of Care 2015). These implementation interventions are designed to increase the uptake of evidence into practice through a range of approaches. We provide further details of included strategies in the Methods section.

How the intervention might work

The success of implementation interventions are contingent on changing the behaviours of individual or teams of health professionals and managers, which may also involve reorganising systems and processes of care (Cane 2012; Ivers 2014; Johnson 2015). Recommended changes might be adding, removing or amending a current clinical practice. Creating sustainable change in clinical practice is notoriously difficult, especially in complex settings such as acute stroke units (Grol 2003). The manner in which specific implementation interventions may bring about improved clinical practice is complicated and still poorly understood. However, it has been suggested that successful change will be more likely to occur when strategies are underpinned by evidence-informed theories about implementation or behaviour change (Abraham 2009). There are numerous theoretical approaches that can be used to guide or understand implementation and behaviour change, with differing lenses with which to view and understand the process of implementation (Birken 2017; Lynch 2018; Nilsen 2015; Skolarus 2017). For example, psychologically derived approaches such as the COM-B model and Behaviour Change Wheel are focussed on factors that influence an individual's motivation, opportunity and capability to change behaviours (Michie 2011). Sociological approaches such as the Normalisation Process Theory can be used to evaluate and influence how individuals and teams work together (May 2009). Other more eclectic approaches, such as the Promoting Action on Research Implementation in Health Services model and the Consolidated Framework for Implementation Research, can be used to study or influence the characteristics of the people involved, the intervention to be implemented, the local and broad context in which the change is to take place, and the process to support the change (Damschroder 2009; Harvey 2016). The widely used Knowledge-To-Action cycle provides an overarching view of implementation of evidence-based practices, starting with knowledge creation and knowledge synthesis, moving on to implementation and sustainability of changes, all of which are underpinned by complex, dynamic knowledge translation processes (Graham 2006).

Therefore, interventions to improve the use of evidence-based recommendations in acute stroke settings might work by affecting a range of factors such as individuals, teams, healthcare settings, processes or ways that peoples and teams work together.

Why it is important to do this review

The provision of evidence-based treatment for patients with stroke is a global priority (Lindsay 2014). In addition to the strong evidence for the benefits of care provided in an inpatient stroke unit (Langhorne 2020), a growing body of evidence is available to guide aspects of acute stroke management to improve patient outcomes, such as thrombolysis (Wardlaw 2014), endovascular clot retrieval (Badhiwala 2015; Goyal 2016), the use of aspirin (Sandercock 2014), and mobilisation after stroke (Langhorne 2018). Clinical practice guidelines have been produced in many countries to provide health professionals with ready access to the best evidence for acute stroke management (e.g. Intercollegiate Stroke Working Party 2016; Powers 2019; Stroke Foundation 2022), and adherence to evidence-based recommendations for acute stroke care has been associated with reduced death and disability (Cadilhac 2004; Cadilhac 2008; Middleton 2011). However, data from clinical registries and audits of clinical practice provide evidence that recommended care is not always optimally provided, even within established acute stroke units (Abraham 2009; King's College London 2020; Stroke Foundation 2021).

Although monitoring care is important for characterising the problems in the delivery of evidence-based care (Cadilhac 2013; Cadilhac 2016), this information alone will have limited effects on adoption of evidence-based recommendations in the absence of implementation strategies to influence professional practice (Davies 2010). A recent review has synthesised the evidence regarding the effect of implementation interventions in stroke rehabilitation settings (Cahill 2020). However, there is little guidance on which implementation strategies improve the provision of recommended care in the environment of acute stroke units. Therefore, this review is important to synthesise the available evidence about the effectiveness of implementation interventions for improving delivery of evidence-based care in acute stroke units.

OBJECTIVES

The primary objective of this review was to assess the effects of implementation interventions (compared to no intervention or other interventions) for increasing adherence to evidence-based recommendations by health professionals working in acute stroke unit environments.

Secondary objectives were to assess factors that may modify the effect of these interventions, and to determine if single or multifaceted strategies are more effective in increasing adherence to evidence-based recommendations by healthcare professionals working in acute stroke unit environments.

METHODS

Criteria for considering studies for this review

Types of studies

We included only studies that were randomised trials or cluster-randomised trials with at least two intervention and two control sites. Studies were included irrespective of publication status or language of publication. We included only randomised trials or cluster-randomised trials to synthesise high-quality evidence (NHMRC 2009). Because there were sufficient numbers of published randomised trials and cluster-randomised trials that met our inclusion criteria, we excluded all other designs (see Differences between protocol and review).

Types of participants

Health professionals

We included studies that described care provided by health professionals directly working with patients admitted with acute stroke, and working within acute stroke units (see *Types of settings*). Types of health professionals suitable for inclusion could include licenced or registered healthcare providers, such as nurses, physicians, pharmacists, physiotherapists, occupational therapists, speech pathologists, dieticians, social workers, psychologists and radiographers.

Patients

To be included, studies needed to report on care provided to patients in acute stroke units within the first seven days of ischaemic or haemorrhagic stroke onset. Studies which evaluated care provided to patients with mixed diagnostic groups including stroke were eligible for inclusion, if data for people with stroke could be extracted separately.

Types of settings

We included studies conducted on acute stroke units or comprehensive stroke units; i.e. discrete wards that admitted patients with acute stroke (usually within hours of onset), where care was provided by a multidisciplinary team, including nursing staff, with expertise in stroke care (Langhorne 2020).

To differentiate our review from the Cochrane Review by Cahill 2020 on implementation interventions in stroke rehabilitation settings, we excluded settings described by Langhorne 2020 as, rehabilitation stroke units that accept patients after a delay, usually of seven days or more, and that focused on rehabilitation. We liaised with the authorship team for the review by Cahill 2020 to ensure included data were only analysed in one of the two systematic reviews.

Where insufficient detail was available in publications to determine the type of setting, we contacted authors. We also contacted authors whose studies were undertaken in hospital environments inclusive of stroke unit and non-stroke unit settings to request data collected in stroke units. Where stroke unit data could not be separated from non-stroke unit data, but had ≥7 0% of data collected in a stroke unit, studies were included in the analysis.

Types of interventions

We included interventions aimed at enhancing adherence to evidence-based recommendations in acute stroke units and changing the behaviour of healthcare professionals, stroke services, or both. Interventions suitable for analysis included delivery arrangements, financial arrangements, governance arrangements and implementation strategies, as defined by EPOC taxonomy (Effective Practice and Organisation of Care 2015). We have used the EPOC taxonomy to describe implementation intervention components. Examples of interventions eligible for inclusion were the creation of new multidisciplinary teams or triage systems or changing facilities (delivery arrangements); use of targeted financial incentives or insurance schemes (financial arrangements); changing the scope of practice or instituting

policies for regulating training by health professionals (governance arrangements); and targetting behaviours of healthcare workers, using reminders, audit and feedback, or local opinion leaders (implementation strategies).

We excluded one specific 'delivery arrangement' intervention that a separate Cochrane Review has already explored and is known to be highly effective; organised care provided in inpatient stroke units (Langhorne 2020).

We included studies that compared an intervention with either no intervention (i.e. usual practice), an active control intervention (i.e. passive information provision only), a multifaceted intervention compared to a single intervention, or a multifaceted intervention compared to another multifaceted intervention.

Types of outcome measures

We only included studies that included a quantifiable measure of adherence to evidence-based practice or processes of care, such as whether a recommended process of care was conducted or the proportion of patients receiving recommended care. We excluded studies that reported on patient outcomes, utilisation outcomes or resource outcomes if there were no measures of adherence to recommended practice because the purpose of the review was to synthesise evidence regarding interventions for the uptake of evidence-based recommendations and some measure of performance must be reported by a study to answer this review's question.

Primary outcomes

Quality of care, as measured by the performance of health professionals or stroke services (or both) in terms of adherence to evidence-based recommendations during the hospital admission. For example, the uptake or increase in:

- recommended diagnostic procedures or assessments;
- acute medical interventions;
- interventions to prevent complications;
- patient-centred goal setting;
- early rehabilitation interventions;
- prescribing patterns for secondary prevention medications;
- referral patterns within the acute setting or to downstream services ;
- assessments for post-acute rehabilitation;
- information provision;
- composite improvement outcomes spanning multiple categories.

Secondary outcomes

- Patient outcomes, including mortality, morbidity, disability levels, medical complications, quality of life, or health benefit measures used in economic analyses such as quality-adjusted life years
- Utilisation, coverage or access outcomes such as length of stay
- Resource use or economic outcomes including direct medical costs, non-direct medical costs such as out-of-pocket expenses, indirect costs such as productivity impacts from inability to work and incremental cost-effectiveness, cost-utility, or cost-benefit impacts of an intervention versus the comparator
- Health professional knowledge, attitudes, and intentions about the evidence-informed recommendations

Search methods for identification of studies

Electronic searches

We identified primary studies using the following bibliographic databases, sources, and methods. We identified related systematic reviews by searching the Cochrane Database of Systematic Reviews, and the databases listed below.

Databases

- Cochrane Central Register of Controlled Trials (CENTRAL) in The Cochrane Library, Wiley (Issue 4 (13, April 2022)
- MEDLINE and MEDLINE In-Process and other non-indexed citations, OvidSP (1950 onwards)
- Embase OvidSP (1947 onwards)
- CINAHL (Cumulative Index to Nursing and Allied Health Literature), EbscoHost (1980 onwards)
- The Joanna Briggs Institute EBP Database, OVID SP (1998 onwards)
- ProQuest Dissertations & Theses Full Text (all dates)

The OVID MEDLINE search strategy was initially developed by author JL in consultation with a research librarian at the University of South Australia. The finalised strategy in the review was revised by author EL in consultation with a research librarian at Flinders University to expand the search, after certain studies known to the authors were not found, and is presented in Appendix 1. The search strategy in Appendix 1 was adapted for other databases using appropriate syntax and vocabulary for those databases. We used randomised trial filters (randomis*, randomiz*, randomly, trial, multicentre or multi centre, and controlled clinical trial) for MEDLINE, Embase and CINAHL. Searches were conducted on 13 April 2022, and not limited by date or language.

Searching other resources

Grey literature

A grey literature search was conducted to identify studies not indexed in the databases listed above on 13 April 2022. Sources included in the search are listed as follows.

- OpenGrey (www.greynet.org/opengreyrepository.html)
- Grey Literature Report, New York Academy of Medicine (www.greylit.org)
- Agency for Healthcare Research and Quality (AHRQ) (www.ahrq.gov)
- National Institute for Health and Clinical Excellence (NICE) (www.nice.org.uk)
- Bielefield Academic Search Engine (BASE) (https://www.base-search.net/)
- Health Services Research Projects in Progress (HSRProj) (https://wwwcf.nlm.nih.gov/hsr_project/home_proj.cfm)
- The Directory of Open Access Repositories (OpenDOAR) (http://www.opendoar.org/)
- The Joanna Briggs Institute (JBI) (http://joannabriggs.org/)
- MedNar (http://mednar.com)

- National Digital Library of Theses and Dissertations (NDLTD) Global Electronic Thesis Database (ETD) (NDLTD) (http://search.ndltd.org/)
- OAIster (OCLC) (http://oaister.worldcat.org/)
- Trip Database (https://www.tripdatabase.com/)
- Trove (National Library of Australia) (https://trove.nla.gov.au/)
- Stroke associations/foundations, websites (https://strokefoundation.org.au/ https://www.stroke.org.uk/ https://www.stroke.org/en/; https://www.heartandstroke.ca/)

Trial Registries

We searched the following registries for ongoing and completed trials on 13 April 2022.

- International Clinical Trials Registry Platform (ICTRP), World Health Organization (WHO) (www.who.int/ictrp/en)
- ClinicalTrials.gov, US National Institutes of Health (NIH) (clinicaltrials.gov)
- ISRCTN registry, BioMed Central (https://www.isrctn.com/)

We also reviewed reference lists of all included studies, relevant systematic reviews and primary studies. We contacted corresponding authors of relevant studies or reviews to assist with identification of unpublished or ongoing studies, and conducted forward citation searching of included studies.

Data collection and analysis

Selection of studies

To ensure consistent application of inclusion criteria, a pilot was conducted where all review authors screened five studies using a predetermined form and guidance instructions in order to optimise consistency of screening decisions. There was 100% consistency between all review authors on the pilot screening.

Two review authors independently screened each title and abstract (screening shared between review authors EL, JL, HC, LC, KB, HJ, TT, LB) to identify potentially relevant papers, including those where the description of the intervention, study design, setting, participants, or outcomes was insufficient to make a decision about inclusion. Studies were not excluded based on publication status or language.

We obtained the full text of all potentially relevant studies and conference abstracts, and two review authors (full-text review shared between review authors EL, HC, JL, LC, LB) independently assessed each study for inclusion in the review according to the eligibility criteria described previously. We resolved disagreements on inclusion or exclusion by discussion until reaching consensus, and by arbitration from a third review author (SM, EMcI or DC).

Review authors who were authors of included studies (EL, DC, SM, JL, EMcI), were not involved in appraising their study for inclusion. There were no unresolved disagreements, so we did not need to refer to the EPOC contact editor.

Reasons for exclusion of full-text studies that had initially been considered potentially relevant were provided in a PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram (Moher 2009).

Contacting corresponding authors

We contacted corresponding authors when insufficient published data were available from full-text studies or conference abstracts. Typically, this was to determine details about the settings, methods of randomisation, or to request further information or access to unpublished results.

Data extraction and management

Two review authors independently undertook data extraction from each included study (data extracted by EL, HC, LC, LB) using a modified and piloted version of the Cochrane EPOC Group Data Collection Checklist (Effective Practice and Organisation of Care 2013a) which was set up in Covidence and included characteristics of the study (design, methods of randomisation), participants, interventions and outcomes. Review authors who were authors of included studies (EL, DC, SM, JL, LMcI), were not involved in extracting data from their study. Data extraction discrepancies were resolved by discussion between the two data extractors.

When standard deviation data for group means were not available, we calculated these using the confidence interval and sample size, as recommended in Higgins 2022.

Two review authors checked data for errors before exporting from Covidence to ReviewManager 5 software (RevMan 2014).

Scope of the implementation intervention

We extracted information that described the scope of the intervention, specifically whether the intervention was targeted at a single acute stroke unit at one study site or at single acute stroke units at multiple study sites with an inter organisation intervention component (such as a regional stroke management improvement collaborative).

Organisational context framing the intervention

We extracted descriptions of the healthcare settings, because we had considered that the type of acute stroke unit might have been a potential effect modifier (Langhorne 2020). For this reason, we extracted other descriptive data when these were available such as the size of stroke unit (number of patients with stroke admitted per year, number of beds allocated to stroke); urban, regional or rural setting; public/private health insurance funding; and level of advantage or disadvantage such as the socioeconomic characteristics of the setting.

Components and complexity of the implementation intervention

We extracted data about the intervention components using a framework based on the Cochrane EPOC taxonomy to guide data extraction (Effective Practice and Organisation of Care 2015). We extracted data such as the specific tools or processes used in the implementation intervention, and we categorised each intervention as either delivery arrangements, financial arrangements, governance arrangements or implementation strategies.

We extracted descriptions of the interventions and implementation methods, and we classified studies as single intervention strategies or multifaceted intervention strategies (two or more implementation strategies), so we could further understand any differences in the effectiveness between single and multifaceted interventions (Squires 2014).

Where available, we extracted data on the intervention duration; the number and composition of participating acute stroke professionals including professional disciplines; and details of the implementation intervention including content, personnel delivering the intervention, delivery method, duration and cost using the Standards for Reporting IMplementation Studies (StaRI) statement (Pinnock 2017).

Complexity of the targeted professional performance change

For each study, we recorded the stated purpose of the targeted change (e.g. appropriate performance based on evidence-informed clinical practice guidelines) and the nature of the desired change (e.g. reduction, increase, cessation).

Three review authors (EL, HC, LB) categorised the complexity of the targeted change in a subjective manner as high, moderate or low using the method proposed by Brennan 2009. We resolved disagreements by discussion amongst all review authors. The categories were based on the following:

- number of changes required;
- extent to which complex judgements or skills are necessary;
- number of staff and professions involved in the change; and
- number of facilities or departments involved in the change.

Assessment of risk of bias in included studies

Two review authors (shared between EL, HC, LC, LB) independently assessed the risk of bias for each included study, using the Cochrane risk of bias tool (Higgins 2011), plus additional criteria developed by the Cochrane EPOC Group (Effective Practice and Organisation of Care 2016b). We resolved any disagreements through discussion involving a third review author (DC). Review authors who were authors of included studies (EL, DC, SM, JL, EMcI) were not involved in appraising their study for risk of bias.

We considered risk of bias in the analysis (see Data synthesis and Sensitivity analysis) and fully described it in the 'Characteristics of included studies' table.

We assessed risk of bias with the following seven domains from the risk of bias tool for randomised trials and cluster-randomised trials: sequence generation; allocation concealment; blinding of participants and personnel (performance bias); blinding of outcome assessors (detection bias); incomplete outcome data; selective outcome reporting; and other potential threats to validity (Higgins 2011). When looking at the "other" sources of bias, we considered domains to assess design-specific threats to validity covered by the Cochrane EPOC group: imbalance of outcome measures at baseline, comparability of intervention and control group characteristics at baseline, protection against contamination and selective recruitment of participants (Effective Practice and Organisation of Care 2016b). We also considered whether the correct analyses for cluster trials were used.

Assessments for the risk of bias criteria were specified in the *Cochrane Handbook for Systematic Reviews of Interventions* and Cochrane EPOC Group guidance, and used to judge whether a study is at low, high, or unclear risk of bias for each domain. For each included study, our assessment of risk of bias for each domain was justified using a descriptive summary of the information that influenced our judgement.

In relation to reporting on secondary outcomes related to costs or the incremental cost-effectiveness of interventions against a comparator group, we had planned to use the Consensus on Health Economic Criteria list to assess methodological quality of economic evaluations (Evers 2005). This would have included noting whether the economic study design was appropriate to the stated objective, the chosen time horizon was appropriate for including all relevant costs and outcomes, costs and outcomes beyond 12 months were discounted appropriately, costs and outcomes were measured and valued appropriately and important variables with uncertain values were appropriately subjected to sensitivity analysis.

Measures of treatment effect

Outcomes

Outcome categories included dichotomous and continuous measures of health professional performance; patient outcomes; utilisation, coverage or access outcomes; resource use or economic outcomes; and health professionals' knowledge, attitudes or intentions. We included all outcomes of the trials if they were outcomes of the review, and noted the primary outcome as identified by the trial authors for each included study. See Differences between protocol and review. Where possible, we verified that the primary outcomes reported in the publications were consistent with those specified in the trial protocols or published trial registration information.

We collected and reported outcomes described by trial authors in Characteristics of included studies, along with how they were measured when this was available (e.g. self-report, chart audit).

Measures of treatment effect for randomised trials and cluster-randomised trials

We extracted the intervention effect estimate for included outcomes reported in the publications along with its P value and 95% confidence interval (CI) or interquartile range (IQR), as appropriate, and the statistical analysis method used to calculate these measures. When trial authors shared previously un-analysed and unpublished data with us, we analysed the data and presented the P value and CI in the relevant additional table presenting summaries about the primary and secondary outcomes, annotated with the word 're-analysed' in the results tables.

To make comparisons between studies, where possible, we calculated the effect estimates. For binary outcomes, our primary effect estimate was the risk ratio (RR); for continuous outcomes, our primary effect estimate was the standardised mean difference (SMD). We calculated P values and 95% confidence intervals for these effect estimates, adjusting appropriately for the design, where possible. We standardised the effect estimates so that ratios greater than one, and differences between the intervention and comparator groups greater than zero, represent benefit for the intervention group (Brennan 2009). When data were available from only one study but not presented as RR or SMD, we presented the effect estimate reported by the study authors.

We used Cochrane's statistical software, Review Manager 5 to perform data analysis (RevMan 2014).

Unit of analysis issues

For cluster-andomised trials where clusters of individuals are randomised to intervention groups, but where inference is

intended at the level of the individual, the analysis must account for correlation of observations within clusters (Brennan 2009). The use of standard statistical methods assumes independence of observations and in clustered studies can result in artificially small P values and overly narrow CIs for the effect estimates (Ukoumunne 1999). We sought assistance from a statistician if trial authors used inappropriate statistical methods to assist us with re-analysis of the data. If re-analysis was not possible, we reported the effect estimate and annotated the phrase 'unit of analysis error'.

We assessed the analysis method of cluster randomised trials, where unit of analysis problems were identified, we conducted analysis adjusting for clustering. We used intracluster correlation coefficient (ICC) to calculate the design effect if available from actual analysis of primary outcomes, otherwise we considered ICC used in sample size calculation of the cluster randomised trial.

Dealing with missing data

We contacted authors of the primary studies to obtain relevant missing data. Where the study involved mixed settings, such as inclusion of stroke patients in stroke and non-stroke units, we contacted the trial authors to request separate data for acute stroke units. Where trials reported that patients with stroke did not spend all their admission in the acute stroke unit, we planned to note this.

We contacted authors to seek clarification when necessary for descriptions of interventions and healthcare site settings, trial conduct, and availability of unpublished outcome data. We considered intention-to-treat analysis as part of risk of bias assessment, and we recorded details of losses to follow-up.

Assessment of heterogeneity

We pooled RRs measuring the effectiveness of the implementation interventions versus no intervention on healthcare professional performance, when outcome measures used were similar between trials, even when interventions were different. For all meta-analyses undertaken, we assessed statistical heterogeneity by visually inspecting the magnitude and direction of the different estimates and quantitatively using I^2 statistic. The interpretation of I^2 values was based on Cochrane Handbook for Systematic Reviews of Interventions guidance, as follows: 0% to 40% might not be important; 30% to 60% may represent moderate heterogeneity; 50% to 90% may represent substantial heterogeneity; 75% to 100% represents considerable heterogeneity.

Assessment of reporting biases

To assess outcome reporting bias, we compared trial protocols and online trial registries with published results to check discrepancies between planned and outcomes reported. We compared the outcomes reported in the methods and results sections of the trial reports, where trial protocols were unavailable.

To reduce the possibility of not locating relevant studies, we included a comprehensive search of the International Clinical Trials Registry Platform, the Australia New Zealand Clinical Trials Registry and the US National Institutes of Health (NIH) Clinical Trials register as part of the search strategy. When required, we contacted investigators of these trials for further information, including the identification of any unpublished results. In addition, we contacted authors of conference abstracts without full text.

We planned to generate funnel plots for meta-analyses including at least 10 trials, to investigate small-study effects.

Data synthesis

There was considerable heterogeneity in this review, including variability in settings, the changes being implemented, implementation interventions used, types of studies and outcomes.

We reported tables of summary statistics for each comparison in each of the included randomised and cluster-randomised trials. The tables included study design, baseline and follow-up summary statistics, effect estimates and statistical significance, and information on effect modifiers. Outcomes reported in these tables included health professionals' performance (e.g. adherence to recommended practice or process of care) and where available, patient outcomes (e.g. mortality, morbidity, disability levels, medical complications, quality of life); utilisation, coverage or access outcomes; resource use or economic outcomes; and health professional knowledge of, attitudes towards, or intentions to use evidence-informed recommendations. We compared the studies as outlined in the 'Subgroup analysis and investigation of heterogeneity' section below.

We summarised the effect estimates for the dichotomous health professionals' performance outcome within comparison, type of implementation intervention and study design. This included the presentation of the median effect estimate, IQR and range. When conducted, we have displayed these data graphically using graphs, such as box plots, where appropriate.

We used meta-analytical methods when possible, to pool RRs from two or more studies measuring the effects of the following four comparisons on health professionals' performance.

- Single implementation interventions versus no intervention.
- Multifaceted implementation interventions versus no intervention.
- Multifaceted implementation interventions versus single interventions.
- Multifaceted implementation interventions versus another multifaceted implementation intervention.

Meta-analysis was only conducted for the comparison of multifaceted implementation interventions versus no intervention. No meta-analysis was conducted for the other comparisons due to the lack of included studies, or inability to logically group studies comparing one multifaceted implementation intervention versus another multifaceted implementation intervention. When included studies had more than one primary outcome measuring quality of care, or more than one primary outcome measuring patient outcomes, we selected the first outcome listed in the main manuscript for inclusion in the meta-analysis.

We pooled intervention effects of results from cluster-randomised trials using random-effects inverse variance meta-analyses.

Subgroup analysis and investigation of heterogeneity

We planned to investigate if the effect on the primary outcome (quality of care) is modified by the type of implementation intervention (i.e. delivery arrangements, financial arrangements, governance arrangements or implementation strategies), because

this information could be used to develop future interventions to improve uptake of evidence-based recommendations. We investigated the effect visually using box plots and formally through subgroup analyses. If sufficient data were available, we planned to use random-effects meta-regression. If sufficient data were available, we planned to perform subgroup analyses to establish effectiveness relative to study population characteristics (e.g. professional disciplines, level of experience), and intervention characteristics (e.g. intended practice change, intervention content, personnel delivering intervention, delivery method, duration).

Sensitivity analysis

For meta-analysis comparing the effectiveness of multifaceted implementation interventions to no interventions on professionals' performance, we undertook a sensitivity analysis to investigate how the inclusion of studies with a high risk of bias in two or more domains affects the pooled intervention effect.

Where there were missing data, we planned to assess how sensitive results are to reasonable changes in the assumptions that are made to account for this, as part of our 'Data synthesis' methods.

Summary of findings and assessment of the certainty of the evidence

We created a summary of findings table for multifaceted interventions versus no interventions, and a summary of findings table for multifaceted interventions versus other multifaceted interventions, and used the following main outcomes.

- Quality of care overview: health professional adherence to evidence-based recommendations during hospital admission
- Quality of care: proportion of patients with ischaemic stroke who received thrombolysis
- Quality of care: proportion of patients who receive a swallow screen within 24 hours of admission
- Patient death or disability at 90 days
- Hospital length of stay
- Resource use or economic outcomes during hospital stay
- Health professional knowledge at 90 days

We selected adherence to evidence-based recommendations as our primary outcome to give an overall view of what strategies are effective for supporting uptake of evidence recommendations in acute settings. We selected two specific quality of care measures for key performance indicators in acute stroke settings - proportion of patients with ischaemic stroke who received thrombolysis and proportion of patients who received a swallow screen. We included the proportion of patients with ischaemic stroke who receive thrombolysis because treatment with thrombolysis has been a major breakthrough in acute stroke management leading to reduced disability in eligible patients, yet timely access to thrombolysis has been identified as an ongoing challenge to optimal stroke care (Campbell 2019). We selected swallow screen because swallow/nutritional assessment is the process of care most commonly used in stroke clinical registries and is associated with lower case fatality (Urimubenshi 2017). Other items were selected which are known to affect or be affected by implementation, namely hospital length of stay, resource use and health professional knowledge, as well as patient death or disability at 90 days.

We used the five GRADE considerations (study limitations, consistency of effect, imprecision, indirectness, and publication bias) to make judgements on the certainty of the available evidence (high-certainty, moderate-certainty, low-certainty, and very low-certainty) for each main outcome (Guyatt 2011). Two of four review authors (EMcI, EL, TT, LB) independently undertook this assessment, resolving discrepancies by discussion. Information was presented in a summary of findings table along with key information on the findings for each outcome including RR, comparative risks and the number of participants (Higgins 2011).

Decisions to down- or upgrade the certainty of the evidence in relation to each outcome were justified within footnotes. GRADE software was used to generate the summary of findings' tables and the EPOC worksheets (Effective Practice and Organisation of Care 2013b; GRADEpro GDT).

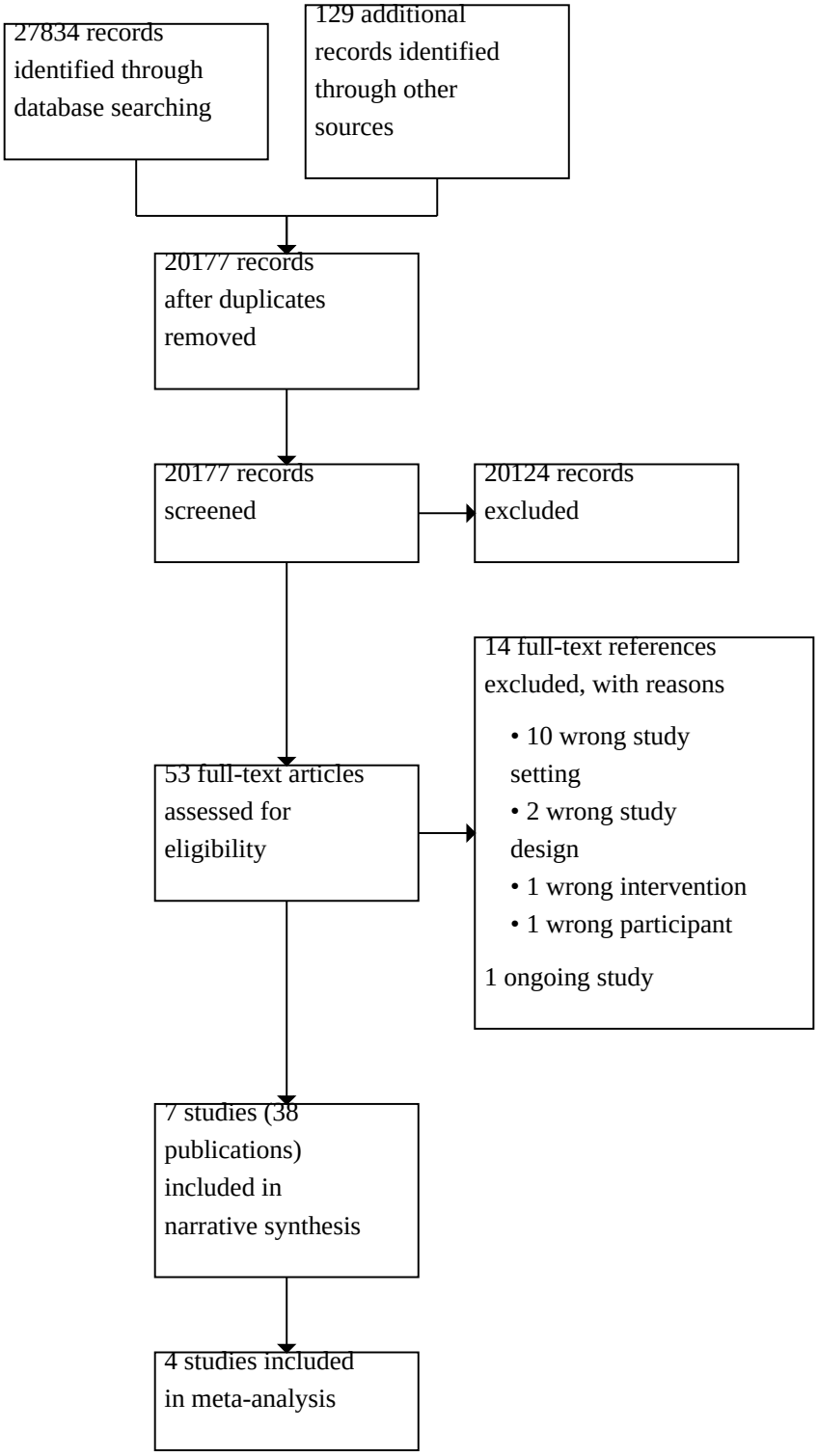
RESULTS

Description of studies

Results of the search

The PRISMA flow diagram of the screening process can be found in Figure 1. A total of 27,834 references were found through database searches and 129 records were identified through searching grey literature repositories and clinical trial registries. After removal of duplicates, 20,177 references were screened, 20,124 were excluded through screening, and 53 full-text references assessed for eligibility. After full-text screening, 14 references were excluded, one further reference was for an ongoing study.

Figure 1. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram



Seven studies, encompassing 38 publications and trial registrations, were included for analysis.

Included studies

A summary of the seven included studies is presented in Table 1 and in Characteristics of included studies.

Study design

All seven studies were cluster-randomised trials (Dirks 2011; Levi 2020; Lynch 2016; Middleton 2011; Power 2014; Shrubsole 2018; Wang 2018). The interventions in the study by Shrubsole 2018 targeted different primary outcomes. All studies other than Shrubsole 2018 were appropriately analysed in terms of adjusting for clustering effects.

Ongoing Study

One cluster-randomised trial conducted in China was ongoing at time of writing (Lou 2017). This study explored the effect of a multifaceted implementation intervention compared to no intervention on quality of care outcomes (door-to-needle and onset-to-needle times), and patient outcomes (symptomatic intracranial haemorrhage at 24 hours, modified Rankin Scale score (mRS)at discharge and at 90 days, death at 90 days) for patients with ischaemic stroke in China. Please see Characteristics of ongoing studies.

Settings and participants

Studies were undertaken at 129 hospitals in Australia (Levi 2020; Lynch 2016; Middleton 2011; Shrubsole 2018), the United Kingdom (Power 2014), China (Wang 2018), and the Netherlands (Dirks 2011).

All studies were undertaken at multiple hospital sites (Dirks 2011; Levi 2020; Lynch 2016; Middleton 2011; Shrubsole 2018; Power 2014; Wang 2018). Data were collected in stroke units only (Dirks 2011, Levi 2020; Middleton 2011, Power 2014, Shrubsole 2018), or at least 70% of data were collected in stroke units (Lynch 2016). We included the study by Wang 2018 where only 62% of data were collected in stroke units, because these authors provided some patient outcome data from stroke units in response to our emailed request.

Health professionals involved in the implementation interventions included nurses (Levi 2020; Lynch 2016; Middleton 2011; Power 2014; Wang 2018); medical professionals (Levi 2020; Lynch 2016; Middleton 2011; Power 2014; Wang 2018); speech pathologists (Lynch 2016; Middleton 2011; Shrubsole 2018); physiotherapists (Lynch 2016; Power 2014); occupational therapists (Lynch 2016; Power 2014); nutritionists and dieticians (Lynch 2016); or multidisciplinary stroke teams with professions not specified (Dirks 2011). Data were collected from 569 health professional participants (nurses, physicians and speech pathologists) in the studies by Levi 2020 and Shrubsole 2018. Data were not collected from health professionals in the remaining five studies (Dirks 2011; Lynch 2016; Middleton 2011; Power 2014; Wang 2018).

Patient participants in six studies were people receiving acute inpatient stroke care, within the first week of stroke (Dirks 2011, Levi 2020; Lynch 2016; Middleton 2011; Power 2014; Wang 2018), whereas only people with aphasia after stroke were included in the study by Shrubsole 2018. Data were collected from 42,489 patients with stroke across the seven included studies. This ranged from 64 patients (Shrubsole 2018) to 22,384 (Levi 2020). Five studies (Dirks 2011; Levi 2020; Lynch 2016; Middleton 2011; Wang 2018) reported demographic features of patient participants. Men made up between 50% (Dirks 2011) to 63% (Wang 2018) of the participants in the trials, with mean ages between 65 years (Wang 2018) and 77.5 (Lynch 2016) years. More than 85% of participants in these studies had ischaemic strokes (see Included studies).

Type of interventions utilised in studies

Studies classified in the EPOC taxonomy of health system interventions (Effective Practice and Organisation of Care 2015) are presented in Table 2. Interventions in all seven studies included implementation strategies targeted at healthcare workers in stroke settings, and interventions in three studies incorporated the use of delivery arrangements (Middleton 2011; Power 2014; Wang 2018). No studies used financial or governance arrangements.

All interventions were multifaceted, ranging from three (Shrubsole 2018) to 13 (Wang 2018) interventional aspects per study.

The most commonly utilised implementation strategies were educational outreach visits from trained staff into the healthcare setting (Lynch 2016; Middleton 2011; Shrubsole 2018; Wang 2018); establishing local consensus processes (Dirks 2011; Lynch 2016; Middleton 2011; Power 2014; Wang 2018); interprofessional education in joint interactive learning (Lynch 2016; Middleton 2011; Power 2014; Wang 2018); conducting audit and feedback (Lynch 2016; Power 2014; Wang 2018) and continuous quality improvement (Dirks 2011; Power 2014; Wang 2018). The most commonly used delivery arrangements were coordination of care and management of care processes (Middleton 2011; Power 2014; Wang 2018). We detailed implementation intervention and targeted evidence-based practice of the included studies in Table 3.

Conceptual framework and theoretical approaches

Included studies were evaluated against the Standards for Reporting Implementation Studies (StaRI) checklist (see Table 4; Table 5; Table 6; Table 7; Table 8; Table 9; Table 10). Of note, only four of the seven included studies (Dirks 2011; Levi 2020; Middleton 2011; Shrubsole 2018) clearly identified as implementation studies, with "implementation" in the title, abstract or as a keyword of the main publication. One study included "implementation" only in the title and abstract of the associated PhD thesis (Lynch 2016). "Quality improvement" was included in the title or as a keyword in a further two studies (Power 2014; Wang 2018).

Five of the seven included studies cited the theoretical approach used to design the implementation interventions (Dirks 2011; Levi 2020; Lynch 2016; Power 2014; Shrubsole 2018). The interventions in the studies by Dirks 2011 and Power 2014 were developed based on the Breakthrough Series model, interventions in Levi 2020 and Shrubsole 2018 were developed using the Behaviour Change Wheel and the interventions used in Lynch 2016 were developed using the Implementation of Change theoretical model. The studies by Middleton 2011 and Wang 2018 did not refer to specific theoretical approaches underpinning the implementation interventions.

Complexity of the targeted professional performance change

Nearly all evidence-based recommendations were deemed to have high complexity (see Table 11) due to multiple professional groups and complex judgements required to implement the change. We

judged the study by Shrubsole 2018 to be of moderate complexity because only speech pathologists were involved.

Targeted evidence-based recommendations

The evidence-based recommendations being addressed in the studies varied between studies. Two studies (Dirks 2011; Levi 2020) focused on treatment with thrombolysis for patients with ischaemic stroke. Three studies focused on bundles of care for all patients with stroke (Middleton 2011; Power 2014; Wang 2018); these included the management of fever, blood glucose and swallowing (Middleton 2011), an "early hours" bundle to be delivered within the first few hours after stroke (Power 2014), and processes of care at admission and discharge (Wang 2018). One study targeted rehabilitation assessments by the multidisciplinary team for all patients with stroke (Lynch 2016) and one sought to address information provision and collaborative goal setting for patients with aphasia (Shrubsole 2018).

Comparison

Five studies compared a multifaceted implementation intervention to no intervention (Dirks 2011; Levi 2020; Middleton 2011; Power 2014; Wang 2018). Two studies compared one multifaceted intervention to another multifaceted intervention (Lynch 2016; Shrubsole 2018).

Outcomes

Quality of care outcomes were reported in all included studies. Two studies reported the proportion of patients receiving thrombolysis (Dirks 2011; Levi 2020). One study reported the proportion of patients receiving each of the following: interventions to manage swallow difficulties, blood glucose and fever (Middleton 2011), documented rehabilitation assessments (Lynch 2016), an 'early hours' bundle of care (brain imaging, aspirin or antiplatelet medication, swallow screen, weight assessment) (Power 2014), processes of care at admission and discharge (admission: treatment with thrombolysis, early antithrombotics, swallow screen, deep vein thrombosis (DVT) prophylaxis; after discharge: use of antithrombotics, anticoagulation for atrial fibrillation, lipid-lowering medication, antihypertensive medication, antidiabetic medication) (Wang 2018) aphasia-friendly information (Shrubsole 2018), and collaborative goal setting (Shrubsole 2018). The study by Power 2014 also reported the proportion of patients who received a rehabilitation bundle of care; we did not include these data in our review because they were included in the review of implementation interventions in stroke rehabilitation settings by Cahill 2020.

Four studies reported patient outcomes (Dirks 2011; Levi 2020; Middleton 2011; Wang 2018). Patient death or disability was reported in four studies (Dirks 2011; Levi 2020; Middleton 2011; Wang 2018), quality of life was reported in two studies (Dirks 2011; Middleton 2011), and one study reported each of the following outcomes; symptomatic intracerebral haemorrhage (Levi 2020), new clinical vascular event (Levi 2020), mean temperature (Middleton 2011), mean blood glucose (Middleton 2011), and aspiration pneumonia (Middleton 2011).

One study (Middleton 2011) reported utilisation outcomes (length of stay). One study reported health professional attitudes towards the evidence-based interventions (Levi 2020), and one study reported health professionals' knowledge (Shrubsole 2018).

No studies reported on resource use or economic outcomes.

Funding sources

Four studies were supported by national government research grants (Dirks 2011; Levi 2020; Middleton 2011; Wang 2018). Other studies were supported by National Stroke Foundation (Lynch 2016), The Health Foundation (Power 2014) and a post-graduate scholarship (Shrubsole 2018).

Unit of analysis issues

All included cluster-randomised trials used analysis that accounted for correlation of observations within clusters, apart from the study by Shrubsole 2018. We sought assistance from a statistician to analyse data from the study by Shrubsole 2018 that were not presented in the manuscript but were provided by the authors as well as data which were presented but not statistically analysed in the manuscript. Due to the nature of the available data and the lack of an available intraclass coefficient, reanalysis was not possible.

Excluded studies

A total of 20,124 references were excluded during title and abstract screening. Fourteen studies were excluded in full-text screening (see Characteristics of excluded studies).

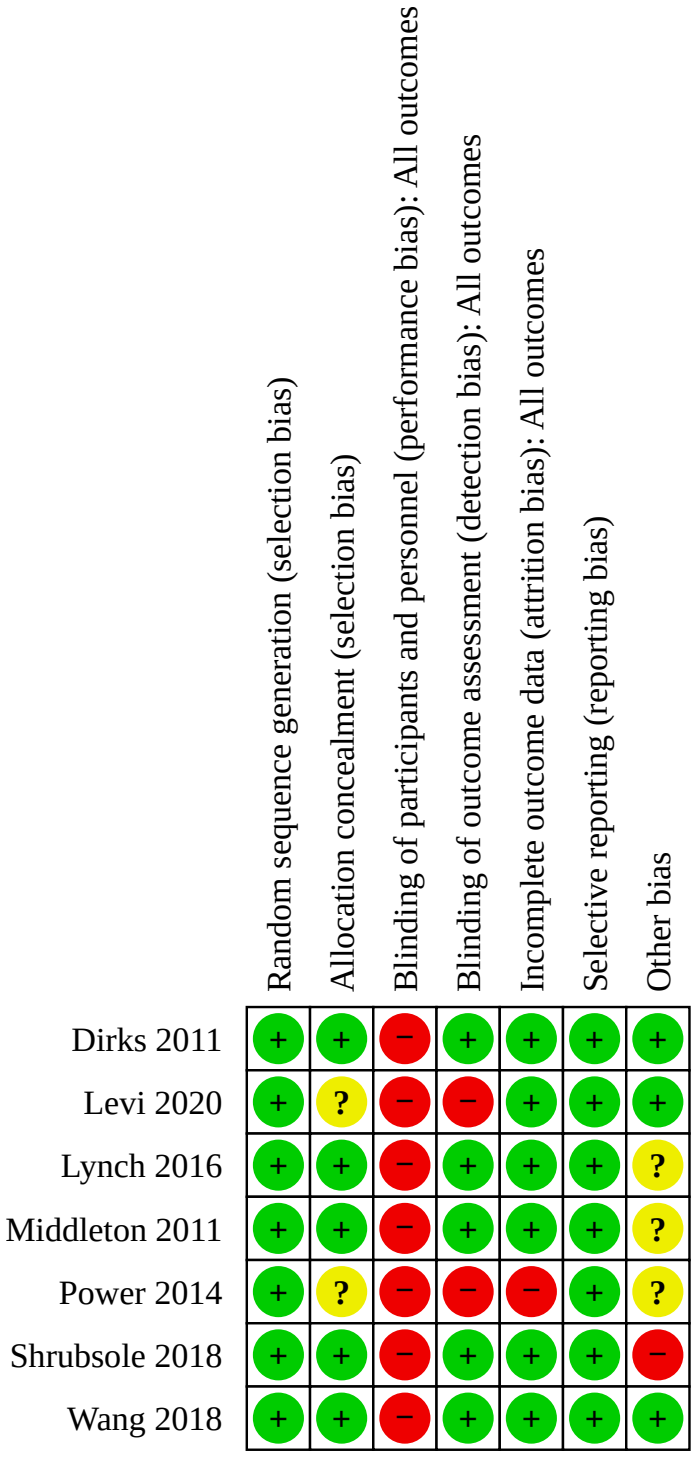
Ten studies were undertaken in study settings that did not meet review criteria, such as gerontology, neurology or general medical wards, emergency departments; stroke rehabilitation units; had <70% of their research undertaken in the stroke unit and authors were contacted but unable to provide stroke unit data separately from non-stroke unit data; or compared interventions undertaken in stroke unit settings to comparators in non-stroke unit settings. Two studies were excluded as they were the wrong study design, because they did not use randomisation procedures.

One study had a wrong intervention which did not aim at enhancing uptake of evidence-based recommendations. Another study had ineligible participants, that is, it did not target health professionals working in a stroke unit.

Risk of bias in included studies

The risk of bias summary can be found in Figure 2. The seven cluster-randomised trials were evaluated using the Cochrane risk of bias tool (Higgins 2011) with additional criteria developed by the Cochrane EPOC Group (Effective Practice and Organisation of Care 2016b).

Figure 2. Risk of bias summary: review authors' judgements about each risk of bias item for each included study.



Random sequence generation (selection bias)

Risk of selection bias was low in all seven cluster-randomised trials (Dirks 2011; Levi 2020; Lynch 2016; Middleton 2011; Power 2014; Shrubsole 2018; Wang 2018), where randomisation to intervention and comparator conditions was adequately undertaken with random number tables or generators.

Allocation of concealment (Selection bias)

Concealment of the allocation sequence was at a low risk of bias in five cluster-randomised trials (Dirks 2011; Lynch 2016; Middleton 2011; Shrubsole 2018; Wang 2018), where allocation was concealed by using blinded or third parties. Two cluster-randomised trials were at unclear risk of bias (Levi 2020; Power 2014), where allocation concealment was not reported.

Blinding of participants and personnel (performance bias)

Due to the nature of interventions that focused on health professionals changing their behaviour, health professional participants could not be blinded to group allocation in any of the included studies.

All seven included cluster-randomised trials (Dirks 2011; Levi 2020; Lynch 2016; Middleton 2011; Power 2014; Shrubsole 2018; Wang 2018) had a high risk of performance bias, because, due to the nature of the interventions, health professionals could not be blinded to the intervention, and the added attention to participants assigned to receive the multifaceted intervention may have influenced them to perform the targeted evidence-based recommendations. This was less of a risk in the study comparing two active interventions and the same outcome measure (Lynch 2016).

Blinding of outcome assessment (detection bias)

There was low risk of detection bias in five cluster-randomised trials (Dirks 2011; Lynch 2016; Middleton 2011; Shrubsole 2018; Wang 2018), which utilised blinded outcome assessors for data collection or statistical analysis. Two cluster-randomised trials (Levi 2020; Power 2014) were at high risk of bias, as clinical trial staff, who were aware of group allocation, undertook data collection.

Incomplete outcome data

Following the *Cochrane Handbook for Systematic Reviews of Interventions'* (Higgins 2011) criterion of high risk of attrition bias as ≥20% of patients in a randomised trial dropping out of the study or being lost to follow-up, one cluster-randomised trial had high risk of bias (Power 2014) where 23% and 11% of patients in the control and intervention groups were lost to follow-up, respectively; the remaining six cluster-randomised trials had low risk of bias with <2 0% of patients dropping out or being lost to follow-up, or no missing data being reported (Dirks 2011; Levi 2020; Lynch 2016; Shrubsole 2018; Middleton 2011; Wang 2018).

Selective reporting

Of the included studies, research protocols were published prior to or during implementation for four cluster-randomised trials (Dirks 2011; Levi 2020; Middleton 2011; Wang 2018). The remaining three randomised trials were retrospectively registered (Lynch 2016; Power 2014; Shrubsole 2018).

Risk of bias for selective reporting was low in all seven cluster-randomised trials. Study outcomes were reported as outlined in research protocols published prior to or during implementation for four studies (Dirks 2011; Middleton 2011; Shrubsole 2018; Wang 2018). Three studies were retrospectively registered in national (Lynch 2016; Shrubsole 2018) and international clinical trials registries (Power 2014). For one of the retrospectively registered studies, study outcomes were fully reported as outlined in the lead author's doctoral thesis (Lynch 2016). In the remaining retrospectively registered study, the study outcomes were pre-defined for performance assessment as per the National Sentinel Audit of Stroke (now the Sentinel Stroke National Audit Programme) in the United Kingdom (Power 2014).

Other potential sources of bias

We considered selective recruitment, protection against contamination, comparability of the intervention and control group at baseline and imbalance of outcome measures at baseline when looking at other risks of bias.

Three studies were at low risk of other sources of bias (Dirks 2011; Levi 2020; Wang 2018), one was at high risk of bias (Shrubsole 2018), whereas it was unclear if there were other sources of bias in the remaining three included studies (Lynch 2016; Middleton 2011; Power 2014).

All seven cluster-randomised trials were at low risk of bias for selective recruitment, as personnel in patient recruitment were blinded to allocation (Middleton 2011), and all adult stroke patients were prospectively included in analysis (Dirks 2011; Levi 2020; Lynch 2016; Middleton 2011; Power 2014; Shrubsole 2018; Wang 2018). All seven cluster-randomised trials were at low risk of bias for protection against contamination, due to geographical separation of intervention and comparator sites (Dirks 2011; Levi 2020; Lynch 2016; Middleton 2011; Power 2014; Shrubsole 2018; Wang 2018). Comparator groups in one study were not told about the details of the intervention condition (Dirks 2011) to protect against contamination. Non-intervention hospitals in one study were aware of their allocation, and awaited entry into the intervention condition, in order to act as a control group (Power 2014). Five cluster-randomised trials (Dirks 2011; Levi 2020; Middleton 2011; Power 2014; Wang 2018) were at low risk of bias from comparability of the intervention and control group at baseline because patient demographic and clinical data were similar between intervention and control groups. Two cluster-randomised trials had an unclear risk of bias, due to baseline characteristics not being reported (Lynch 2016; Shrubsole 2018). Three cluster-randomised trials were at low risk of bias from imbalance of outcome measures at baseline because baseline data were similar between groups (Dirks 2011; Wang 2018) or sites were stratified by baseline performance prior to randomisation (Levi 2020). Four cluster-randomised trials had an unclear risk of bias from imbalance of outcome measures at baseline, as baseline data were collected, but not compared between-groups (Lynch 2016; Middleton 2011; Power 2014; Shrubsole 2018). One study was at high risk of bias due to not accounting for clustering in the analysis (Shrubsole 2018) and despite assistance from a statistician, we were unable to appropriately reanalyse the data from this study.

Effects of interventions

See: **Summary of findings 1** Summary of findings

Five cluster-randomised trials (Dirks 2011; Levi 2020; Middleton 2011; Power 2014; Wang 2018) compared a multifaceted implementation intervention to no intervention (see Summary of findings 1). Two cluster-randomised trials (Lynch 2016; Shrubsole 2018) compared one multifaceted implementation intervention to another multifaceted implementation intervention (see Summary of findings table 2). No studies were identified for our first comparison of single implementation intervention to no intervention, or our third planned comparison of multifaceted implementation intervention versus single implementation intervention. Details of the implementation interventions are described in Description of studies.

Comparison 1. Single Implementation intervention versus no intervention

No included studies compared a single implementation intervention to no intervention.

Comparison 2. Multifaceted Implementation intervention versus no intervention

Quality of care outcomes

The five included studies that compared a multifaceted implementation intervention to no intervention (Dirks 2011; Levi 2020; Middleton 2011; Power 2014; Wang 2018) reported quality of care measures in terms of adherence to evidence-based recommendations as primary or secondary outcomes, and included data from 6944 people with stroke. To pool results regarding the effect of implementation interventions on quality of care outcomes, we selected the first quality of care outcome listed in each paper; these were the proportions of patients treated with thrombolysis (Dirks 2011; Levi 2020 , 1379 participants), proportions of patients who received a swallow screen (Middleton 2011, 483 participants) and compliance with a bundle of care (Power 2014; Wang 2018 5082 participants). We adjusted all data included in the meta-analysis for clustering. We did not include data from Wang 2018 (4800 participants) in our meta-analysis because <70% of data were collected in stroke units.

Based on data from the cluster-randomised trials by Dirks 2011; Levi 2020; Middleton 2011 and Power 2014, we are uncertain whether a multifaceted implementation intervention comprising implementation strategies and delivery arrangements leads to any change in adherence to evidence-based recommendations compared with no intervention (risk ratio (RR)1.73; 95% confidence interval (CI) 0.83 to 3.61; 4 cluster-randomised trials; 76 clusters; 2144 participants, I^2 =92%, very low-certainty evidence, Analysis 1.1). The certainty of this evidence was downgraded 3 levels due to serious risk of bias (high risk of detection bias in 2 studies), inconsistency (high, unexplained heterogeneity), imprecision (wide 95% confidence intervals). While the RRs from the studies by Dirks 2011; Levi 2020 and Power 2014 were very similar, there was no overlap with the RR of these studies with the RR from the results of Middleton 2011. Participant groups (multidisciplinary health professionals providing care to patients with stroke), complexity of the desired change in practice, country in which the studies were conducted, risk of bias and nature of the intervention could not explain the difference between the results of these studies. We reviewed the results of the study by Wang 2018 which were not included. These findings were similar to the overall findings, with no increase in an all-or-none measure of adherence to the 9 performance measures, but a small increase in a composite score of the percentage of performance measures adhered to (Wang 2018).

We conducted subgroup analyses on quality of care outcomes according to the intervention delivered and compared results from the subgroup of studies that delivered implementation interventions only to the subgroup of studies that delivered implementation strategies plus delivery arrangements. This subgroup analysis did not alter the results for the main outcomes (Analysis 1.1).

Other planned subgroup analyses (to establish effectiveness relative to study population characteristics and intervention characteristics) were not conducted due to lack of available data.

We conducted a sensitivity analysis without data from the studies by Levi 2020 or Power 2014 which both had high risks of bias in two or more domains, which resulted in a similar effect between the intervention and control groups while maintaining very high heterogeneity (RR 2.72; 95% CI 0.41 to 17.96, 2 cluster randomised trials; 1167 participants, I^2 =97%, Analysis 1.2).

Quality of care: Uptake or increase in recommended diagnostic procedures or assessments

No included studies reported outcomes relevant to uptake or increase in recommended diagnostic procedures or assessments.

Quality of care: Uptake or increase in acute medical interventions

We included two cluster-randomised trials which reported measures of uptake or increase in acute medical interventions (Dirks 2011; Levi 2020), see Table 12. Both studies reported the proportion of patients treated with thrombolysis and door-to-needle time in patients who were treated with thrombolysis. Dirks 2011 also reported the proportion of patients with ischaemic stroke admitted within four hours of symptom onset who were treated with thrombolysis. Both studies used a multifaceted intervention comprised of implementation strategies. Data regarding proportions of patients treated with thrombolysis and door-to-needle time were meta-analysed.

Treatment with thrombolysis

Based on data from the two cluster-randomised trials by Dirks 2011 and Levi 2020, a multifaceted implementation intervention comprising implementation strategies probably leads to little or no difference in increasing the proportion of patients with stroke treated with thrombolysis compared to no intervention (RR 1.14, 95% CI 0.94 to 1.37, 2 trials; 32 clusters; 1228 participants, moderate-certainty evidence, Analysis 1.3). The certainty of this evidence was downgraded lone level due to risk of bias (high risk of detection bias in one1 study). However, multifaceted implementation interventions probably increase the proportion of patients treated with thrombolysis who are admitted within four hours of symptom onset following ischaemic stroke compared to no intervention (adjusted mean difference (MD) 1.58%, 95% CI 1.11 to 2.27, 1 trial; 12 clusters; 5515 participants, moderate-certainty evidence). The certainty of this evidence was downgraded one level due to imprecision (only one trial).

Door-to-needle time

Based on data from the tertiary (Dirks 2011) and post-hoc (Levi 2020) analysis of the two cluster-randomised trials, multifaceted interventions comprised of implementation strategies probably

lead to little or no difference in reducing door-to-needle time in people who received thrombolysis compared to no intervention (standardised mean difference (SMD) 0.04 minutes, 95% CI -0.13 to 0.20, 2 cluster randomised trials; 32 clusters, 568 participants, moderate-certainty evidence, Analysis 1.4). The certainty of this evidence was downgraded one level due to serious risk of bias (high risk of detection bias and post-hoc analysis in one study).

Quality of care: Uptake or increase in interventions to prevent complications

We included one cluster-andomised trial which reported measures of uptake or increase in interventions to prevent complications (Middleton 2011), see Table 13. This study used a multifaceted intervention incorporating implementation strategies and delivery arrangements, and reported the proportion of patients meeting all (n = 2) swallow care elements, all (n = 2) fever elements and all (n=5) blood glucose care elements.

Swallow screen

Based on data from the study by Middleton 2011, a multifaceted implementation intervention incorporating implementation strategies and delivery arrangements probably leads to an increased proportion of patients who receive a swallow screen within 24 hours of admission compared to no intervention (RR 6.76, 95% CI 4.44 to 10.76, 1 cluster-randomised trial; 19 clusters, 1804 participants; moderate-certainty evidence). The certainty of evidence was downgraded one level due to imprecision (only one trial).

Preventing complications to manage swallowing difficulties

Based on data from the study by Middleton 2011, multifaceted implementation interventions incorporating both implementation strategies and delivery arrangements probably lead to an increased proportion of patients who were provided with treatment elements to manage swallowing (swallow screen and referral to speech pathologist if failed swallow screen) compared to no intervention (difference in absolute change 13%, 95% CI 5.5 to 21; 1 trial; 19 clusters; 1804 participants; moderate-certainty evidence). A multifaceted implementation intervention probably improves the proportion of patients referred to speech pathologists if they fail their swallow screen compared to no intervention (adjusted MD 14%; 95% CI 5.6 to 21; 1 trial; 19 clusters; 1804 participants; moderate-certainty evidence), see Table 13. The certainty of evidence regarding the proportion of patients who received treatment elements to manage swallowing and the proportion of patients referred to speech pathologists if they fail their swallow screen were both downgraded one level due to imprecision (only one trial, wide confidence intervals).

Preventing complications to manage blood glucose

A multifaceted implementation intervention comprising implementation strategies and delivery arrangements probably leads to an increased proportion of patients who were provided with treatment elements to manage blood glucose compared to no intervention (adjusted MD 3.6%, 95% CI 0.8 to 6.3; 1 trial; 19 clusters; 1804 participants; moderate-certainty evidence). The certainty of this evidence was downgraded one level due to imprecision (only one trial).

These interventions probably increase the uptake of some individual elements of blood glucose management compared to no intervention: measurement of venous blood glucose on hospital admission (adjusted MD 23.8%; 95% CI 16 to 31; moderate-certainty evidence), finger-prick blood glucose on stroke unit admission (adjusted MD 8.8; 95% CI 0.7 to 17; moderate-certainty evidence), uptake of finger-prick blood glucose test everyone to six hours for the first 72 hours depending on previous value compared to no intervention (adjusted MD 24.0%; 95% CI 17 to 31; moderate-certainty evidence). However, these interventions probably do not increase adherence to recommendations about saline infusion when indicated (adjusted MD 0.2%; 95% CI -4.7 to 5.1; moderate-certainty evidence) or insulin infusion when indicated (adjusted MD -1.4%; 95% CI -4.3 to 1.6; moderate-certainty evidence), see Table 13. The certainty of evidence for these elements were downgraded one level due to imprecision (only one trial, wide confidence intervals).

Preventing complications to manage fever

Based on data from the study by Middleton 2011, multifaceted implementation interventions comprising implementation strategies and delivery arrangements probably increase the proportion of patients who were provided with treatment elements to manage fever compared to no intervention (adjusted MD 14.8%, 95% CI 7.9 to 22; 1 trial; 19 clusters; 1804 participants; moderate-certainty evidence). This improvement involves both elements of fever management: it probably increases monitoring and charting of patients' temperatures during the first 72 hours of stroke unit admission (adjusted MD 15.0%; 95% CI 7.9 to 22; moderate-certainty evidence) and probably increase numbers of patients with temperatures >37.5°C being treated with paracetamol (adjusted MD 12.2%; 95% CI 5.0 to 20; moderate certainty evidence), compared to no intervention, see Table 13. The certainty of this evidence was downgraded one level due to imprecision (only one trial).

Quality of care: Uptake or increase in patient-centred goal setting

No included studies reported outcomes relevant to uptake or increase in patient-centred goal setting.

Quality of care: Uptake or increase in early rehabilitation interventions

No included studies reported data relevant to uptake or increase in early rehabilitation intervention.

Quality of care: Uptake or increase in prescribing patterns for secondary prevention

No included studies reported data relevant to uptake or increase in prescribing patterns for secondary prevention.

Quality of care: Uptake or increase in referral patterns within the acute setting or to downstream services

One cluster-randomised trial (Middleton 2011) reported on referrals to speech pathology for people with failed swallow screen. These results are presented in the *Uptake or increase in interventions to prevent complications* section.

Quality of care: Uptake or increase in assessments for post-acute rehabilitation

No included studies reported outcomes relevant to uptake or increase in assessments for post-acute rehabilitation.

Quality of care: Uptake or increase in information provision

No included studies reported outcomes relevant to uptake or increase in information provision.

Quality of care: Composite improvement outcomes spanning multiple categories

We included two cluster-randomised trials which reported composite measures spanning multiple categories (Power 2014, Wang 2018). The study by Power 2014 had a high risk of bias in three domains. These two studies were designed to investigate the use of multifaceted interventions targeted at healthcare workers and delivery arrangements, see Table 14.

Power 2014 reported a composite score of four quality of care outcomes on or within 24 hours of admission (brain scan, aspirin, swallow screen, weight assessment). Wang 2018 reported a composite score of nine quality of care indicators (thrombolysis within three hours of symptom onset, antithrombotics within 48 hours of admission, swallow screen, deep vein thrombosis prophylaxis, prescription at hospital discharge of: antithrombotics, anticoagulants for atrial fibrillation, statins for high blood cholesterol, antihypertensives, hypoglycaemic medication for diabetes), measured as a total number of eligible measures and an all-or-nothing score (whether they received all the care measures for which they were eligible). However, less than 70% of the data in the study by Wang 2018 were collected in hospitals with stroke units, and authors did not respond to requests to provide composite scores from hospitals with stroke units (total number of eligible measures and all-or-nothing score) so these data could not be included in the review.

Based on data from Power 2014, we do not know if a multifaceted implementation intervention encompassing strategies targeting healthcare workers and delivery arrangements improves adherence to composite improvement outcomes spanning multiple categories compared to no intervention (relative improvement 10.9%, 95% CI 1.3 to 20.6, 1 cluster-randomised trial, 24 clusters, 6592 participants, very low-certainty evidence, Table 14). The certainty of this evidence was downgraded three levels due to very serious risk of bias (downgraded two levels due to high risk of detection bias and high risk of attrition bias) and imprecision (only one trial, wide confidence intervals).

Patient outcomes

We included four cluster-randomised trials that reported patient outcomes (Dirks 2011; Levi 2020; Middleton 2011; Wang 2018), see Table 15.

All studies used multifaceted implementation interventions targeting healthcare workers; Middleton 2011 and Wang 2018 also used interventions targeted at delivery arrangements.

To pool results regarding the effect of implementation interventions on patient outcomes, we selected the first patient outcome listed in each paper; outcomes were death or disability at three months (Dirks 2011), proportion of patients treated with Intravenous thrombolytic therapy (IVT) not experiencing favourable three months outcomes in terms of death and dependency (Levi 2020), death and dependency at 90 days (Middleton 2011), and disability at three months (Wang 2018). All four studies measured patient outcomes using the modified Rankin Scale (mRS), a rating scale of patient function, but the studies used different cut-off scores (Dirks 2011 grouped scores 0-2, 3-6; Levi 2020 and Middleton 2011 grouped scores 0-1, 2-6; Wang 2018 grouped 0-2, 3-5, 6). Less than 70% of the data in the study by Wang 2018 were collected in hospitals with stroke units, so these data were not included in the meta-analysis. Based on results from these studies, a multifaceted intervention comprised of implementation strategies and delivery arrangements probably leads to little or no difference in the risk of death, disability or dependency at 90 days compared to no intervention (RR 0.93; 95% CI 0.85 to 1.02; 3 cluster-randomised trials; 51 clusters; 1228 participants, I^2 = 0%, moderate-certainty evidence, Analysis 2.1). The certainty of this evidence was downgraded one level due to indirectness (different cut-off scores used). The results of Wang 2018, where there was a lower proportion of patients with disability at 3 months (mRS 3-5) in sites allocated to multifaceted intervention (odds ratio (OR) 0.76; 95% CI 0.63 to 0.91) were different to the results from the meta-analysis, and may be attributable to the different settings (only 62% of participating sites had stroke units) or the different mRS cut-off score used.

Sensitivity analysis without Levi 2020 which had high risk of bias in two domains, resulted in a similar effect (0.92; 95% CI 0.82 to 1.03, 2 cluster-randomised trials; 993 participants, I^2 =0%, Analysis 2.2).

Patient outcomes: Mortality at 90 days

Three cluster-randomised trials which used a multifaceted implementation intervention comprising implementation strategies and delivery arrangements (Middleton 2011; Wang 2018) or implementation strategies only (Dirks 2011) reported mortality outcomes at 90 days. Less than 70% of the data in the study by Wang 2018 were collected in hospitals with stroke units, and the authors did not respond to requests to provide 90-day mortality from hospitals with stroke units, so we did not include results from this study in the meta-analysis. Based on the results from Dirks 2011 and Middleton 2011, multifaceted implementation interventions comprising implementation strategies with or without the addition of delivery arrangements do not affect the risk of mortality at 90 days compared to no intervention (RR 0.89, 95% CI 0.63 to 1.25, 2 cluster-randomised trials; 1197 participants, high-certainty evidence, Analysis 2.3). The results of Wang 2018 (no significant difference in mortality rates between groups) were consistent with the results from the meta-analysis.

Patient outcomes: Mortality at 1 to 4 years

Two cluster -randomised trials which used multifaceted implementation interventions comprising implementation strategies and delivery arrangements compared to no intervention reported mortality outcomes at 12 months (Wang 2018) and between 1–4 years (Middleton 2011). The authors of Wang 2018 provided 12-month mortality data from hospitals with stroke units. Based on the results of these studies, multifaceted implementation interventions comprising implementation strategies and delivery arrangements probably make no difference to the risk of death at 12 months and beyond compared to no intervention (RR 0.84, 95% CI 0.65 to 1.08; 2 cluster-randomised trials; 1744 participants; moderate-certainty evidence, Analysis 2.4). The certainty of this evidence was downgraded one level due to risk of bias (selective outcome reporting: outcome not named in protocol).

Patient outcomes: Disability at 90 days

Despite the same patient outcome measure (modified Rankin Scale, mRS) being used for disability in the cluster-randomised trials by Dirks 2011; Levi 2020, Middleton 2011 and Wang 2018, four different cut-offs were used across the four trials (mRS data were analysed with three different cut-offs in the main and post-hoc analysis by Levi 2020). "Favourable outcome" (mRS 0-1, indicating no symptoms or no significant disability) for patients treated with thrombolysis was reported by Levi 2020 and death or dependency (mRS 2-6, indicating slight/moderate/moderately severe/severe disability or death) for patients receiving care on stroke units was reported by Middleton 2011 (i.e. the cut-offs were the same in the studies by Levi 2020 and Middleton 2011, but the outcome reported differed). "Good clinical outcome" (defined as mRS 0-2, equates to no symptoms, no significant disability or slight disability) was reported by Dirks 2011 and in a post hoc analysis by Levi 2020. "Poor outcome" (mRS 5-6, equates to severe disability or death) was reported in a post hoc analysis by Levi 2020, and disability (mRS 3-5, equates to moderate/moderately severe/severe disability) and death were reported separately by Wang 2018.

Based on the results of Levi 2020 and Middleton 2011, multifaceted implementation interventions comprised of implementation strategies with or without delivery arrangements improves the risk of patients having no symptoms or no significant disability at three months (mRS 0-1) compared to no intervention (RR 1.35, 95% CI 1.14 to 1.59; 2 cluster-randomised trials; 39 clusters; 755 participants, high-certainty evidence, Analysis 2.5).

Based on the results of Dirks 2011 and post-hoc analysis of Levi 2020, multifaceted implementation interventions comprising implementation strategies probably make no difference in patients' risk of having slight or no significant disability (mRS 0-2) at 90 days compared to no intervention (RR 1.01. 95% CI 0.75 to 1.36; 2 cluster-randomised trials; 32 clusters; 761 participants, moderate-certainty evidence, Analysis 2.6). The certainty of evidence was downgraded one level due to risk of bias (selective outcome reporting: post-hoc analysis).

Based on the results of post-hoc analysis of Levi 2020, multifaceted implementation interventions comprising implementation strategies may make little or no difference in patients' risk of having a poor outcome (mRS 5-6) at 90 days compared to no intervention (odds ratio 1.44, 95% CI 0.61 to 3.41; 1 cluster-randomised trial; 20 clusters; 1559 participants included in post-hoc analysis, low certainty evidence). The certainty of evidence was downgraded two levels due to risk of bias (selective outcome reporting: post-hoc analysis) and imprecision (only one study).

Patient outcomes: Disability at 1 year

In the study by Wang 2018, a smaller proportion of participants in stroke units at intervention sites (which received implementation strategies and delivery arrangements) were living with moderate or severe disability (mRS 3-5) at 12 months compared to participants in stroke units at non-intervention sites (158/1340, 11.8% versus 134/974 13.76%, respectively, data from hospitals with stroke units supplied by authors, not adjusted for clustering, very low-certainty evidence). The certainty of this evidence was downgraded three levels due to risk of bias (unit of analysis error, no adjustment for clustering) and very serious imprecision (downgraded two levels due to only one trial, 95% CI not presented).

Patient outcomes: Dependency at 90 days

Based on the results of Middleton 2011, a multifaceted implementation intervention probably makes little or no difference in the level of functional dependency at 90 days compared to no intervention measured with the Barthel Index using two cut off scores (Cut-off ≥ 95 [equating to slight dependency]: difference in absolute change 9.5%; 95% CI -0.5 to 19.5; cut off ≥60 [equating to moderate dependency]: 2.5%; 95% CI -3.6 to 8.6; 1 cluster-randomised trial, 19 clusters; 1696 participants; moderate-certainty evidence), see Table 15. The certainty of this evidence was downgraded one level due to imprecision (only one trial, wide 95% CI).

Patient outcomes: Quality of life

Quality of life was reported by Dirks 2011 using the European Quality of Life Scale (EuroQOL) (EuroQoL Group 1990), and by Middleton 2011 using the SF-36 (Brazier 1992), where the physical and mental component summaries were reported separately. A multifaceted implementation intervention compared to no intervention may lead to little or no improvement in quality of life (mean EuroQOL-derived utility weight 0.56 in the intervention group vs 0.58 in the no-intervention group, adjusted difference 0.01; 95% CI -0.05 to 0.08 [Dirks 2011]; adjusted absolute difference in SF-36 mean physical component summary score 3·4; 95% CI 1·2 to 5·5 [Middleton 2011]; absolute adjusted difference in SF-36 mean mental component summary 0.5; 95% CI -1.9 to 2.8, low-certainty evidence).

The certainty of evidence was downgraded two levels due to indirectness (different measures used, unable to pool results) and imprecision (variable results between studies), see Table 15.

Patient outcomes: Adverse events

Different studies reported different adverse events. Middleton 2011 reported no significant difference in the incidence of having a discharge diagnosis of aspiration pneumonia in patients receiving care at sites that received a multifaceted intervention compared to sites that received no implementation intervention (2% versus 3%, respectively, p=0.82; 1 cluster randomised trial, 19 clusters; 1,696 participants), Levi 2020 reported no significant difference in the proportion of patients at intervention and non-intervention sites who were treated with thrombolysis who experienced a symptomatic intracranial haemorrhage (1.4% vs 3.0% respectively, OR 0.52; 95% CI 0.09 to 2.93, 1 cluster-randomised trial, 20 clusters; ,559 participants included in post-hoc analysis, data provided by authors) and Wang 2018 reported a smaller proportion of participants in intervention sites experienced new clinical vascular events at 12 months compared to patients at non-intervention sites (146/1680, 8.7% versus 141/1299, 10.9%, respectively; data supplied by authors, not adjusted for clustering). Given the variations in adverse events reported, we do not know if multifaceted interventions reduce the incidence of adverse events compared to no intervention because the certainty of this evidence is very low, see Table 15. The certainty of evidence was downgraded three levels to very low due to risk of bias (unit of analysis error), serious indirectness (different measures used, different time frames) and imprecision (variable results).

Patient outcomes: Other measures

Based on the results of the study by Middleton 2011, a multifaceted implementation intervention comprising

implementation strategies and delivery arrangements is probably effective at reducing the mean temperature for the first 72 hours after stroke unit admission (difference in absolute change 0.09°C; 95% CI 0.04 to 0.15; 1 cluster-randomised trial, 19 clusters; 1,696 participants; moderate-certainty evidence), and reducing mean finger-prick blood glucose for the first 72 hours after stroke unit admission (difference in absolute change 0.54 mmol/L; 95% CI 0.08 to 1.01; 1 cluster-randomised trial, 19 clusters; 1696 participants; moderate-certainty evidence), compared to no intervention, see Table 15. The certainty of this evidence was downgraded one level given imprecision (only one trial).

Utilisation, coverage or access outcomes

We included one study that reported the effect of implementation interventions on outcomes related to utilisation, coverage or access. The cluster-randomised trial by Middleton 2011 reported on length of hospital stay, see Table 16. Based on the results of this study, a multifaceted implementation intervention comprising implementation strategies and delivery arrangements probably makes little or no difference on length of hospital stay compared to no intervention (effect after adjusting for pre-intervention levels and clustering 1.5 days; 95% CI -0.5 to 3.5; 1 cluster-randomised trial; 19 clusters; 1804 participants; moderate- certainty evidence). The certainty of this evidence was downgraded one level given imprecision (onlyone1 trial).

Resource use and economic outcomes

No included studies reported outcomes relevant to resource use and economic outcomes.

Health professional knowledge, attitudes, intentions

We included one study that reported measures of health professional attitudes, but no studies reported on health professional knowledge or intentions. The cluster-randomised trial by Levi 2020 had a high risk of bias in two domains, and reported the effect of multifaceted implementation interventions comprising implementation strategies on the attitudes of physicians and nurses. Data were collected via a paper-based 74-item researcher-developed survey, with items rated using a 5-point Likert scale (strongly disagree, disagree, agree, strongly agree, not applicable), see Table 17. Based on the results of this study, we do not know if a multifaceted implementation intervention compared to no intervention improves health professionals' attitudes regarding hospital-level performance indicators, feedback and training (between group difference in change in mean survey scores from pre-intervention to post-intervention after adjusting for baseline thrombolysis rate 0.21; 95% CI 0.09 to 0.34, 1 cluster-randomised trial, 19 clusters, 917 health professional participants, very low-certainty evidence), health professionals' perception about the evidence base for intravenous thrombolysis and its implementation (between group difference in change in mean survey scores after adjusting for baseline thrombolysis rate 0.21, 95% CI 0.06 to 0.36, 1 cluster-randomised trial, 19 clusters, 917 health professional participants, very low-certainty evidence) and their perception about personal stroke skills and hospital stroke care policies (between group difference in change in mean survey scores after adjusting for baseline thrombolysis rate 0.04, 95% CI -0.10 to 0.18, 1 cluster-randomised trial, 19 clusters, 917 health professional participants, very low-certainty evidence) or the perceptions towards emergency service (between group difference in change in mean survey scores after adjusting for baseline thrombolysis rate 0.10, 95% CI -0.07 to 0.27, 1 cluster-randomised trial, 19 clusters, 917 health professional participants, very low certainty evidence) compared to no intervention. The certainty of this evidence was downgraded three levels due to serious risk of bias (low response rate), imprecision (only one1 trial, not powered for this outcome measure) and indirectness (non-validated survey).

Comparison 3. Multifaceted implementation intervention versus single implementation intervention

No included studies compared a multifaceted implementation intervention to a single implementation intervention.

Comparison 4. Multifaceted implementation intervention versus other multifaceted implementation intervention

Quality of care outcomes

Two studies compared one multifaceted intervention with another multifaceted intervention (Lynch 2016; Shrubsole 2018). Lynch 2016 compared a multifaceted intervention to a dual-strategy education intervention and measured quality of care in terms of proportion of stroke patients who received an assessment for rehabilitation by hospital clinicians. Shrubsole 2018 compared two multifaceted implementation interventions (both comprising workshops, education and provision of resources) and measured quality of care in terms of proportions of patients with aphasia who received collaborative goal setting (focus of one intervention) and proportions of patients with aphasia who were provided aphasia-friendly information (focus of the alternate intervention).

We could not pool these results to determine the effect of one multifaceted implementation to another multifaceted implementation intervention because there are three different implementation interventions and three different primary outcome measures that cannot be grouped logically to allow comparison. Neither study reported improvements in care associated with one intervention compared to another.

Quality of care: Uptake or increase in recommended diagnostic procedures or assessments

No included studies reported outcomes relevant to uptake or increase in recommended diagnostic procedures or assessments.

Quality of care: Uptake or increase in acute medical interventions

No included studies reported outcomes relevant to uptake or increase in acute medical interventions.

Quality of care: Uptake or increase in interventions to prevent complications

No included studies reported outcomes relevant to uptake or increase in interventions to prevent complications.

Quality of care: Uptake or increase in patient-centred goal setting

We included one study that reported measures about patient-centred goal setting. Based on the results of Shrubsole 2018, we do not know whether a multifaceted intervention (interactive education session and workshop, and provision of resources to promote collaborative goal setting with people with aphasia) increases the proportion of patients who receive patient-centred goal setting compared to another multifaceted implementation intervention (interactive education session and workshop, and provision of resources to promote the provision of information

about aphasia) because the certainty of this evidence is very low (5/25 versus 0/36 received documented goal-setting respectively; 1 cluster-randomised trial; 4 clusters; 61 participants; unit of analysis error, very low-certainty evidence) (Table 18). The certainty of evidence was downgradedthree3 levels due to very serious risk of bias (downgraded two levels because baseline characteristics not compared between groups, unable to reanalyse and account for clustering because unable to calculate the intra class correlation (ICC) with available data, or data from the published literature) and imprecision (only one 1 trial, small sample size, no power calculation).

Quality of care: Uptake or increase in early rehabilitation interventions

No included studies reported outcomes relevant to uptake or increase in early rehabilitation interventions.

Quality of care: Uptake or increase in prescribing patterns for secondary prevention

No included studies reported outcomes relevant to uptake or increase in prescribing patterns for secondary prevention.

Quality of care: Uptake or increase in assessments for post-acute rehabilitation

We included one study that reported measured about assessment for post-acute rehabilitation. The cluster-randomised trial by Lynch 2016 compared a multifaceted implementation intervention targeting healthcare workers (educational materials, educational outreach visits, interprofessional education, local consensus processes, local opinion leaders, reminders and tailored interventions) with the dual-strategy implementation intervention of education only (educational materials, educational outreach visits) on the proportion of patients who were assessed for ongoing rehabilitation needs.

Based on these results, a multifaceted implementation intervention compared to a dual-strategy education intervention probably makes little or no difference to the proportion of patients assessed for ongoing rehabilitation needs (OR 1.29, 95% CI 0.63 to 2.67; 1 cluster-randomised trial; 10 clusters; 586 participants, moderate-certainty evidence), Table 19. The certainty of this evidence was downgraded one level due to imprecision (only one trial).

Quality of care: Uptake or increase in referral patterns within the acute setting or to downstream services

No included studies reported outcomes relevant to uptake or increase in referral patterns within the acute service or to downstream services.

Quality of care: Uptake or increase in information provision

We included one study that reported outcomes about information provision. Based on the results from the study by Shrubsole 2018, we do not know whether one multifaceted intervention (interactive education session and workshop, and provision of resources to promote the provision of information about aphasia) is more effective for increasing the proportion of patients and families who were provided information about aphasia compared to another multifaceted intervention (interactive education session and workshop, and provision of resources to promote collaborative goal setting with people with aphasia) because the certainty of this evidence is very low (19/36 versus 8/25 received information about aphasia respectively; 1 cluster-randomised trial, 4 clusters, 61 participants, very low-certainty evidence), see Table 20. The certainty of evidence was downgraded three levels due to very serious risk of bias (downgradedtwo2 levels because baseline characteristics not compared between groups, unable to reanalyse and account for clustering because unable to calculate ICC with available data, or data from the published literature) and imprecision (only one trial, small sample size, no power calculation).

Quality of care: Composite improvement outcomes spanning multiple categories

No included studies reported outcomes relevant to composite improvement outcomes spanning multiple categories.

Patient outcomes

No included studies reported outcomes relevant to patient outcomes.

Utilisation, coverage or access outcomes

No included studies reported outcomes relevant to utilisation, coverage or access outcomes.

Resource use and economic outcomes

No included studies reported outcomes relevant to resource use and economic outcomes.

Health professional knowledge, attitudes, intentions

Shrubsole 2018 compared the effect of one multifaceted intervention (interactive education session and workshop, and provision of resources to promote the provision of information about aphasia) to another multifaceted intervention (interactive education session and workshop, and provision of resources to promote collaborative goal setting with people with aphasia) on health professional's knowledge, attitudes and intentions about information provision and collaborative goal setting, using a survey developed by the authors, see Table 21. The survey comprised a mix of positive and negative statements (68 statements in total), and respondents were asked to indicate their agreement using a 5-point Likert scale (strongly disagree, disagree, neither agree nor disagree, agree, strongly agree).

The authors of the study by Shrubsole 2018 provided us with data, but we were unable to analyse these appropriately and account for clustering because we could not calculate an ICC with the available data, or find an ICC to impute from the published literature. Therefore, we do not know if a multifaceted implementation intervention (workshop, education and resources to promote information provision) increases health professionals' knowledge about information provision compared to a different multifaceted implementation intervention (workshop, education and resources about collaborative goal-setting) (mean score out of 5 on author-designed survey 3.83 versus 3.83, respectively; unit of analysis error, 1 cluster-randomised trial, 4 clusters, 37 health professional participants, very low-certainty evidence). Similarly, we do not know if a multifaceted implementation intervention targeting information provision improves health professionals' attitudes to information provision (mean score out of 5 on author-designed survey 3.97 intervention targetting information provision versus 4.17 intervention targetting goal-

setting ; unit of analysis error, 1 cluster-randomised trial, 4 clusters, 37 health professional participants, very low-certainty evidence) and intention to provide information (mean score out of 5 on author-designed survey 4.31 intervention targetting information provision versus 4.35 intervention targetting goal-setting; unit of analysis error, 1 cluster-randomised trial, 4 clusters, 37 health professional participants, very low certainty evidence) compared to a multifaceted implementation intervention targeting goal setting. The certainty of this evidence was downgraded three levels due to very serious risk of bias, indirectness (non-validated survey used to measure knowledge, attitudes and intentions) and imprecision (only one trial, small sample size, no power calculation).

We do not know if a multifaceted implementation intervention (workshop, education and resources to support goal setting) improves health professionals' knowledge about goal setting compared to a multifaceted implementation intervention targeting information provision (workshop, education and resources)(mean score out of 5 on author-designed survey 4.17 versus 4.3, respectively, 0.32; 95% CI 0.09 to 0.54, unit of analysis error, 1 cluster-randomised trial, 37 health professional participants, very low-certainty evidence). We are uncertain if a multifaceted intervention targetting goal setting has effect on health professionals' attitudes to goal setting (mean score out of 5 on author-designed survey 4.06 intervention targetting goal-setting versus 4.06 intervention targetting information provision; unit of analysis error, 1 cluster-randomised trial, 4 clusters, 37 health professional participants, very low-certainty evidence) and intention to set goals (mean score out of 5 on author-designed survey 4.38 intervention targetting goal-setting versus 4.41 intervention targetting information provision; unit of analysis error, 1 cluster-randomised trial, 4 clusters, 37 health professional participants, very low-certainty evidence) compared to a multifaceted implementation intervention targeting information provision. The certainty of this evidence was downgraded 3 levels due to very serious risk of bias (unable to account for clustering in analysis), imprecision (only one trial, small sample size, no power calculation) and indirectness (non-validated author-designed survey used to measure knowledge).

DISCUSSION

Summary of main results

We included five cluster-randomised trials which compared a multifaceted implementation intervention to no intervention (Dirks 2011; Levi 2020; Middleton 2011; Power 2014; Wang 2018), and two cluster-randomised trials that compared one multifaceted implementation intervention with another multifaceted implementation intervention (Lynch 2016; Shrubsole 2018). None of the included studies compared a single intervention with no intervention, or with a multifaceted intervention. The included studies involved 129 clusters and over 26,000 patients with stroke. Interventions used in all the included studies were multifaceted, involving between two (education-only group in Lynch 2016) and 13 (Wang 2018) intervention strategies. Interventions in all studies included implementation strategies targeting healthcare workers, three studies also included delivery arrangements (Middleton 2011; Power 2014; Wang 2018). None of the included studies reported the effectiveness of financial or governance arrangements. All studies included a measure of quality of care, which was our primary outcome. Four studies (Dirks 2011; Levi 2020; Middleton 2011; Wang 2018) included patient outcomes. Two studies collected data about health professional knowledge or attitudes (Levi 2020; Shrubsole 2018). All included studies were subject to performance bias, because health professional participants and personnel could not be blinded to group allocation. Three studies had high risks of bias in two or more domains.

The primary objective of this review was to assess the effects of implementation interventions for promoting the uptake of evidence-based recommendations in acute stroke unit hospital settings. We are uncertain whether a multifaceted implementation intervention targeting healthcare workers and delivery arrangements improve adherence to evidence-based recommendations compared to no intervention (very low-certainty evidence). A multifaceted intervention probably leads to little or no difference in the proportion of patients with stroke treated with thrombolysis compared to no intervention (moderate-certainty evidence). A multifaceted implementation intervention comprising implementation strategies and delivery arrangements increases the proportion of patients who receive a swallow screen within 24 hours of admission compared to no intervention (high-certainty evidence).

We found that a multifaceted implementation intervention probably leads to little or no reduction in death, disability or dependency at 90 days compared to no intervention (moderate-certainty evidence), and probably leads to little or no difference in hospital length of stay compared to no intervention (moderate-certainty evidence). None of our included studies reported resource use or economic outcomes, or health professional knowledge.

In interpreting these results, it is important to be mindful of several factors. Identification of relevant studies was unexpectedly complicated; only four of the included studies were clearly classified as implementation studies (Dirks 2011; Levi 2020; Middleton 2011; Shrubsole 2018) by including the term "implementation" in the title, abstract or as a keyword. "Quality improvement" was an alternate term that was used as a keyword or contained within the title or abstract of two studies we included in this review (Power 2014; Wang 2018).

No two studies used the same intervention protocol or the same outcome measures, which made synthesis of the results complex. Interventions differed in terms of who delivered and participated in the intervention, duration of the intervention, and included intervention strategies. Further, the terminology used to describe the intervention strategies varied between studies. Every included study was designed to investigate the effectiveness of implementation interventions for healthcare professionals and targeted at specific settings, and the included implementation strategies covered 15 of the 19 subcategories listed in the Effective Practice and Organisation of Care 2015 taxonomy. Delivery arrangements were also used in three included studies, with two of the five categories of Delivery arrangements from the Effective Practice and Organisation of Care 2015 taxonomy described. No studies included financial arrangements or governance arrangements.

Our secondary objectives were to identify and describe any factors that may modify the effect of implementation interventions or influence the uptake of recommendations in acute stroke units. Our subgroup analyses based on the different interventions used (implementation strategies only or implementation strategies

and delivery arrangements) in the included studies comparing a multifaceted implementation intervention to no intervention did not identify a clear benefit of one intervention type over another.

Overall completeness and applicability of evidence

A strength of this review is that it is based on a thorough, complete and current search of the relevant literature; we screened over 20,000 titles and abstracts, we searched grey literature and published and screened published and unpublished trials. All the included studies used multifaceted interventions, so we were unable to achieve our other secondary objective regarding comparing the effectiveness of single to multifaceted interventions. We specifically focused on interventions for the uptake of evidence-based recommendations delivered in stroke unit settings. Accordingly, we excluded numerous studies which investigated implementation interventions when the care was not provided by healthcare workers who worked in stroke units. It was highlighted to us during this review that care delivery in the USA tends not to be delivered in wards that meet the definition of stroke units, so no study conducted in the USA met our inclusion criteria. Further, care provided to people in low-income countries tends not to be provided in resource-intensive stroke units (Chimatiro 2019), which then limits the findings of this review to only countries with well-funded health services. Further, we excluded studies conducted at regional centres without stroke units, as well as interventions delivered by ambulance officers or only emergency department staff. Recent developments of time-critical interventions for stroke such as clot retrieval and thrombolysis have led to stroke care becoming more integrated between ambulance services and hospital departments. Stroke unit staff now frequently attend to patients with suspected stroke in the emergency department (Meretoja 2013), and sometimes even in "stroke ambulances" or mobile stroke units, where stroke unit staff are first responders when people in the community have a suspected stroke (Fassbender 2017). Defining which interventions were delivered by stroke unit staff, rather than emergency department staff or paramedics, frequently required us to clarify with the authors. We did include studies that were attended by stroke unit staff in other settings (for example, stroke unit staff in emergency departments) but excluded studies when stroke unit staff were not physically present with the patient (for example, remote consultations with regional centres via telehealth). While our review has had a specific focus on implementation studies conducted in acute stroke inpatient settings, it has meant that we have not collated the full remit of acute stroke implementation studies which are now occurring prior to arriving at the hospital or only in emergency departments by non-stroke unit staff, or via hub-and-spoke models in regional healthcare facilities.

We requested and were provided with additional data from authors of three cluster-randomised trials (Levi 2020; Shrubsole 2018; Wang 2018). We contacted Wang 2018 for data from hospitals with stroke units, (< 70% of the data presented in the manuscript were collected in hospitals with stroke units), and these authors were able to provide some of the data we requested. Two studies we reviewed at full text were subsequently excluded when authors were unable to provide us with stroke unit-only data (Machline-Carrion 2018; Panella 2012). We also contacted Levi 2020 for secondary outcome data (proportions of patients treated with thrombolysis who experienced favourable outcomes or symptomatic intracranial haemorrhage), which were presented for each site, but not for group allocation. Shrubsole 2018 provided data regarding staff intentions and attitudes which were presented as summaries in the manuscript.

One ongoing study (Lou 2017) was identified which explored the effect of a multifaceted implementation intervention based on the Behaviour Change Wheel compared to no intervention on door-to-needle times for patients with ischaemic stroke. Findings from this study (including >1500 patients with ischaemic stroke who received thrombolysis within 4.5 hours) may increase the certainty of evidence about the effect of implementation interventions compared to no interventions on quality of care outcomes (currently very low-certainty evidence), patient outcomes at 90 days (currently moderate-certainty evidence), and door-to-needle times in people who received thrombolysis (currently moderate-certainty evidence).

We included all patient outcomes that were reported by study authors. Our included studies did not report all measures from a standard set of stroke measures recommended by international experts for evaluating value-based health care (Salinas 2016). Studies in this review included patient outcomes that measured most aspects of survival and disease control (i.e. we extracted data about mortality, new stroke and symptomatic intracerebral hemorrhage (ICH) after treatment with thrombolysis), but no study included an outcome related to adherence to smoking cessation advice. Patien--reported health status was collected in most studies that measured patient outcomes, but this often focussed on health-related quality of life, motor functioning, mood and pain, whereas no included study measured fatigue, cognitive function or ability to communicate.

We could not make any conclusions about the effectiveness of financial or governance arrangements, or the influence of financial or governance arrangements on our findings and how these may be leveraged to improve the uptake of evidence-based recommendations in acute stroke settings as no studies reported these.

Quality of the evidence

The studies included in this review comprised seven cluster-randomised trials, four of which were judged to be at high risk of bias in one domain, and the remaining three were at high risk of bias in two or more domains.

We are uncertain whether a multifaceted implementation intervention targeting healthcare workers and delivery arrangements improves our primary outcome, which was adherence to evidence-based recommendations compared to no intervention. The certainty of this evidence was very low, and was downgraded three levels due to serious risk of bias, inconsistency and imprecision. A major factor in downgrading the certainty of evidence was due to the high, unexplained heterogeneity in the results (inconsistency). Further well-conducted and well-described studies addressing this question are very likely to have an important impact on the effect estimate and our confidence in the findings.

We found moderate-certainty evidence that a multifaceted implementation intervention increases the proportion of patients with ischaemic stroke who receive thrombolysis compared to no intervention. We downgraded the certainty of evidence for receipt

of thrombolysis one level due to risk of bias (one of thetwo included studies reporting this outcome had a high risk of detection bias). We found high-certainty evidence that a multifaceted implementation intervention increases the proportion of patients who receive a swallow screen within 24 hours of admission to a stroke unit compared to no intervention. We found low-certainty evidence that a multifaceted implementation intervention may have little to no effect on patient death or disability at three months post-stroke compared to no intervention. We downgraded the certainty of the evidence about patient death or disability two levels because of indirectness (the same outcome measure [modified Rankin Scale] was used to measure death or disability in the three included studies, but different cut-off scores were used) and imprecision. We found moderate-certainty evidence that a multifaceted implementation intervention probably leads to little or no difference in hospital length of stay compared to no intervention. We downgraded the certainty of evidence for hospital length of stay one level due to imprecision (wide 95% confidence intervals (CIs, crossing line of no effect).

Potential biases in the review process

We sought to reduce the introduction of biases into the review process by following procedures recommended by Cochrane (Higgins 2022). and by adhering to processes outlined in our published protocol (Luker 2017). Of note, two review authors (EL, SM) of this review are lead authors of studies which we have included in the review. We ensured that these review authors and their study co-authors were not involved in the screening, selection or data extraction of their own studies. Though publication bias can be an issue, we located numerous unpublished studies published as conference abstracts, and have noted one ongoing study we identified through searching clinical trials registers. There were too few studies to formally assess the presence of publication bias. We followed systematic processes through the review and used a cautious approach in interpreting the evidence, to protect against our personal views biassing our interpretation of the review findings. We included only cluster-randomised trials, most of which were well-designed and adequately powered, which provided a higher level of evidence, although the health professionals taking part in the implementation interventions were not blinded to treatment allocation in any of the studies.

A limitation of this review is that we did not use a validated randomised controlled trial filter as part of our literature search.

Agreements and disagreements with other studies or reviews

This is the first systematic review to address the effectiveness of interventions for the uptake of evidence-based recommendations in acute stroke settings, and was conducted within a similar time frame as a systematic review about the effectiveness of implementation interventions in stroke rehabilitation (Cahill 2020). We found that we are uncertain if a multifaceted implementation intervention leads to any change in adherence to evidence-based recommendations compared to no intervention in acute stroke settings. Similarly, Cahill 2020 reported uncertainty whether implementation interventions promote the uptake of evidence-based practices in stroke rehabilitation settings. Both reviews included a reasonably small numbers of studies (nine studies in Cahill 2020, seven studies in our review), and we agree with the conclusions of Cahill 2020 that more studies evaluating how to improve implementation of evidence-based recommendations in acute and rehabilitation stroke settings are vital to ensure that more people with stroke receive evidence-based care.

Our review has incorporated the effectiveness of care pathways for acute stroke which was the focus of a previous review (Kwan 2002). Care pathways are one strategy within the category of coordination of care and management of care processes, which are a form of delivery arrangement (Effective Practice and Organisation of Care 2015). Three of the included studies included coordination of care and management of care processes (Middleton 2011; Power 2014; Wang 2018), but in all studies, these were combined with numerous implementation strategies, and we were unable to identify the effect of care pathways alone. Given that we were unable to analyse the effect of coordinating care processes, we would agree with the findings of the review by Kwan 2002 that there remains insufficient supporting evidence to justify the routine implementation of care pathways for acute stroke management.

AUTHORS' CONCLUSIONS

Implications for practice

We are uncertain whether a multifaceted implementation intervention compared to no intervention improves adherence to evidence-based recommendations in acute stroke settings, because the certainty of evidence is very low.

Much remains unclear in terms of how best to promote the uptake of evidence-based recommendations in acute stroke settings, and which strategies to use. Until more research is conducted, and more evidence becomes available to guide practice, we would advocate for clinicians and researchers to team together to plan, measure, evaluate and share their findings about service improvements in acute stroke settings.

Implications for research

This review highlights an urgent need for more research to be conducted to investigate how to successfully implement evidence-based recommendations in acute stroke settings. We would encourage researchers interested in improving the uptake of evidence-based recommendations in acute stroke settings to describe their interventions using consistent terminology, and we would advocate that authors refer to the EPOC taxonomy (Effective Practice and Organisation of Care 2015) when describing their interventions to facilitate clarity and ability to compare methods and results. Further, use of consistent outcome measures (and consistent cut-off points of commonly used outcome measures) between studies would assist to build the body of knowledge about interventions for the uptake of evidence-based recommendations in acute stroke settings.

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REFERENCES

References to studies included in this review

Dirks 2011 *{published data only}***ISRCTN20405426**

Dippel DW. Promoting acute thrombolysis for ischemic stroke. ISRCTN Registry 2005. [DOI: https://doi.org/10.1186/ISRCTN20405426]

Dirks M, Baeten SA, Dippel DW, van Exel NJ, van Wijngaarden JD, Huijsman R, et al, on behalf of the PRACTISE Investigators. Real-life costs and effects of an implementation program to increase thrombolysis in stroke. *Neurology* 2012;**79**(6):508-14. [DOI: 10.1212/WNL.0b013e31826356bf]

Dirks M, Niessen LW, Huijsman R, van WijngaardenJ, Minkman MM, Franke CL, et al. Promoting acute thrombolysis for ischaemic stroke (PRACTISE). *International Journal of Stroke* 2007;**2**(2):151-9. [DOI: 10.1111/j.1747-4949.2007.00119.x]

* Dirks M, Niessen LW, van Wijngaarden JD, Koudstaal PJ, Franke CL, van Oostenbrugge RJ, et al. Promoting thrombolysis in acute ischemic stroke. *Stroke* 2011;**42**(5):1325-30. [DOI: 10.1161/STROKEAHA.110.596940]

Levi 2020 *{published and unpublished data}*

Hasnain MG, Levi CR, Ryan A, Hubbard IJ, Hall A, Oldmeadow C, et al. Can a multicomponent multidisciplinary implementation package change physicians' and nurses' perceptions and practices regarding thrombolysis for acute ischemic stroke? An exploratory analysis of a cluster-randomized trial. *Implementation Science* 2019;**14**:98.

Hasnain MG, Paul CL, Attia JR, Ryan A, Kerr E, D'Este C, et al. Door-to-needle time for thrombolysis: a secondary analysis of the TIPS cluster randomised controlled trial. *BMJ Open* 2019;**9**:e032482.

Hasnain MG, Paul CL, Attia JR, Ryan A, Kerr E, Oldmeadow C, et al. Thrombolysis implementation intervention and clinical outcome: a secondary analysis of a cluster randomized trial. *BMC Cardiovascular Disorders* 2020;**20**:432.

* Levi CR, Attia JA, D'Este C, Ryan, AE, Henskens F, Kerr E, et al, on behalf of the TIPS (Thrombolysis Implementation in Stroke) Study Group. Cluster-randomized trial of thrombolysis implementation support in metropolitan and regional Australian Stroke Centers: lessons for individual and systems behavior change. *Journal of the American Heart Association* 2020;**9**:e012732.

Paul C. Changing the health system to increase the adoption of "clot busters" in stroke treatment. Australian New Zealand Clinical Trials Registry 2013:https://www.anzctr.org.au/Trial/Registration/TrialReview.aspx?id=362806.

Paul CL, Levi CR, D'Este CA, Parsons MW, Bladin CF, Lindley RI, et al, on behalf of the Thrombolysis ImPlementation in Stroke (TIPS) Study Group. Thrombolysis ImPlementation in Stroke (TIPS): evaluating the effectiveness of a strategy to increase the adoption of best evidence practice – protocol for a cluster randomised controlled trial in acute stroke care. *Implementation Science* 2014;**9**:38.

Lynch 2016 *{published and unpublished data}***ACTRN12616000340437**

ACTRN12616000340437. Efficacy of the Assessment for Rehabilitation Tool in improving proportions of patients with stroke assessed for rehabilitation: a mixed methods cluster randomised trial. Australian New Zealand Clinical Trials Registry 2016. [ANZCTR: https://www.anzctr.org.au/Trial/Registration/TrialReview.aspx?id=370314]

Lynch E, Luker JA, Cadilhac DA, Fryer CE, Hillier SL. Improving rehabilitation assessment and referral practices for patients with stroke in Australia. A mixed methods cluster-randomized implementation trial. *International Journal of Stroke* 2015;**10**(2 Suppl):178. [DOI: https://doi.org/10.1111/ijs.12479]

* Lynch EA, Cadilhac, DA, , Luker JA, Hillier, SL. Education-only versus a multifaceted intervention for improving assessment of rehabilitation needs after stroke; a cluster randomised trial. *Implementation Science* 2016;**11**(1):120. [DOI: https://dx.doi.org/10.1186/s13012-016-0487-2]

Lynch EA. Implementing the Assessment for Rehabilitation Tool in Australian acute stroke units. A mixed methods cluster randomised trial. University of South Australia 2015. [URL: http://researchoutputs.unisa.edu.au/11541.2/122543]

Middleton 2011 *{published and unpublished data}***ACTRN12608000563369**

Middleton S, Levi C, Ward J, Grimshaw J, Griffiths R, D'Este C, et al. Fever, hyperglycaemia and swallowing dysfunction management in acute stroke: a cluster randomised controlled trial of knowledge transfer. *Implementation Science* 2009;**4**:16. [DOI: https://dx.doi.org/10.1186/1748-5908-4-16]

ACTRN12608000563369. Managing fever, hyperglycaemia and dysphagia in acute stroke: the Quality in Acute Stroke Care Trial. Australian New Zealand Clinical Trials Registry 2008. [ANZCTR: https://www.anzctr.org.au/Trial/Registration/TrialReview.aspx?id=83282]

Cheung NW, Levi C, McElduff P, Ward J, Grimshaw, JM, Dale S, et al. Glucose management in a cluster randomized trial of evidence based treatment protocols for acute stroke (QASC). *Diabetes* 2014;**63**:A111. [URL: http://ads-adea-2014.p.asnevents.com.au/days/2014-08-27/abstract/16472]

Dale S, Levi C, Ward J, Grimshaw JM, Jammali-Blasi A, D'Este C, et al. Barriers and enablers to implementing clinical treatment protocols for fever, hyperglycaemia, and swallowing dysfunction in the Quality in Acute Stroke Care (QASC) Project--a mixed methods study. *Worldviews on Evidence-Based Nursing* 2015;**12**(1):41-50. [DOI: https://dx.doi.org/10.1111/wvn.12078]

Drury P, Levi C, D'Este C, Dale S, Griffiths R, Grimshaw J, et al. The QASC cluster randomised controlled trial of an intervention to improve management of fever, hyperglycaemia and swallowing dysfunction in acute stroke: did clinician behaviour change? *Cerebrovascular Diseases* 2011;**31**(Suppl2):88. [DOI: http://dx.doi.org/10.1159/000329448]

Drury P, Levi C, D'Este C, McElduff P, McInnes E, Hardy J, et al. Quality in Acute Stroke Care (QASC): process evaluation of an intervention to improve the management of fever, hyperglycemia, and swallowing dysfunction following acute stroke. *International Journal of Stroke* 2014;**9**(6):766-76. [DOI: https://dx.doi.org/10.1111/ijs.12202]

Drury P, Quinn C, McInnes, L, Hardy J, Levi CR, D'Este C, et al. Implementation of an evidence-based treatment protocol to manage dysphagia in acute stroke: QASC, a cluster randomised controlled trial. *International Journal of Stroke* 2012;**7**(1 Suppl):25. [DOI: http://doi.org/10.1111/j.1747-4930.2012.00907.x]

Drury P, Levi C, McInnes E, Hardy J, Ward J, Grimshaw JM, et al. Management of fever, hyperglycemia, and swallowing dysfunction following hospital admission for acute stroke in New South Wales, Australia. *International Journal of Stroke* 2013;**9**(1):23-31. [DOI: 10.1111/ijs.12194]

Drury P. Evaluation of a behaviour change intervention targeting evidence-based management of fever, hyperglycaemia and swallowing dysfunction following acute stroke. Australian Catholic University 2014. [URL: https://researchbank.acu.edu.au/theses/490/]

Middleton S, Levi C, D'Este C, Dale S, Drury P, Griffiths R, et al. The QASC cluster randomised controlled trial of a team-based intervention to improve management of fever, hyperglycaemia and swallowing dysfunction in acute stroke: patient 90-day outcomes. *Cerebrovascular Diseases* 2011;**31**(Suppl 2):87. [DOI: http://dx.doi.org/10.1159/000329448]

Middleton S, Levi C, Ward J, Grimshaw J, Griffiths R, D'Este C, et al. Death, dependency and health status 90 days following hospital admission for acute stroke in NSW. *Internal Medicine Journal* 2011;**41**(10):736-43. [DOI: http://dx.doi.org/10.1111/j.1445-5994.2010.02330.x]

Middleton S, Levi C, Ward J, Grimshaw J, Griffiths, R. Cluster randomised controlled trial (CRCT) of a multidisciplinary, team-building intervention to manage fever, sugar and swallowing (FeSS) in acute stroke. Nursing Monograph 2009;(1):19-21.

* Middleton S, McElduff P, Ward J, Grimshaw JM, Dale S, D'Este, C, et al, on behalf of the QASC Trialists Group. Implementation of evidence-based treatment protocols to manage fever, hyperglycaemia, and swallowing dysfunction in acute stroke (QASC): a cluster randomised controlled trial. *Lancet* 2011;**378**(9804):1699-706. [DOI: https://dx.doi.org/10.1016/S0140-6736(11)61485-2]

Middleton S, Mnatzaganian G, Coughlan K, D'Este C, Low Choy N, Cadilhac D, et al. Can a nurse-initiated intervention to manage fever, hyperglycaemia and swallowing post stroke reduce long-term mortality? Follow-up results from the QASC trial. *European Stroke Journal* 2016;**1**(1 Suppl):629. [DOI: http://dx.doi.org/10.1177/2396987316642910]

Middleton S, Ward, J, Grimshaw J, Griffiths R, D'Este C, Dale S, et al. Does a team base knowledge transfer intervention to manage fever, hyperglycaemia and swallowing dysfunction, improve 90-day outcomes following stroke? *Stroke* 2011;**42**(11):e587-e588. [DOI: http://dx.doi.org/10.1161/STR.0b013e3182301bf4]

Middleton S. An outcomes approach to stroke care: the importance of teamwork and evidence-based nursing care. *International Journal of Stroke* 2012;**7**:224-6.

Middleton, S, Coughlan K, Mnatzaganian G, Low Choy N, Dale S, Jammali-Blasi A, et al. Mortality reduction for fever, hyperglycemia, and swallowing nurse-initiated stroke intervention: QASC Trial (Quality in Acute Stroke Care) follow-up. *Stroke* 2017;**48**(5):1331-6. [DOI: https://dx.doi.org/10.1161/STROKEAHA.116.016038]

Power 2014 *{published data only}***13893902**

Carter P, Ozieranski P, McNicol S, Power M, Dixon-Woods M. How collaborative are quality improvement collaboratives: a qualitative study in stroke care. *Implementation Science* 2014;**9**:32. [DOI: 10.1186/1748-5908-9-32]

ISRCTN13893902. Improving clinical stroke care using a stroke collaborative approach. ISRCTN Registry 2013. [DOI: https://doi.org/10.1186/ISRCTN13893902]

* Power M, Tyrrell PJ, Rudd AG, Tully MP, Dalton D, Marshall M, et al. Did a quality improvement collaborative make stroke care better? A cluster randomized trial. *Implementation Science* 2014;**9**(1):40. [DOI: 10.1186/1748-5908-9-40]

Shrubsole 2018 *{published and unpublished data}***10.1111/1460-6984.12419**

Shrubsole K, Worrall L Power E, O'Connor DA. The Acute Aphasia IMplementation Study (AAIMS): a pilot cluster randomized controlled trial. *International Journal of Language and Communication Disorders* 2018;**53**:1021-56. [DOI: 10.1111/1460-6984.12419]

Wang 2018 *{published and unpublished data}*

Wang Y, Li Z, Xian Y, Zhao X, Li H, Shen H, et al, on behalf of GOLDEN BRIDGE–AIS investigators. Rationale and design of a cluster-randomized multifaceted intervention trial to improve stroke care quality in China: the GOLDEN BRIDGE-Acute Ischemic Stroke. *American Heart Journal* 2015;**169**(6):767-74.e2. [DOI: https://dx.doi.org/10.1016/j.ahj.2015.03.008]

* Wang Y, Li Z, Zhao X, Wang C, Wang X, Wang D, et al, on behalf of GOLDEN BRIDGE-AIS Investigators. Effect of a multifaceted quality improvement intervention on hospital personnel adherence to performance measures in patients with acute ischemic stroke in China: a randomized clinical trial. *JAMA: The Journal of the American Medical Association* 2018;**320**(3):245-54. [DOI: 10.1001/jama.2018.8802]

Wang Y. Intervention to bridge the evidence-based gap in stroke care quality (GoldenBridge). ClinicalTrials.gov 2017. [CTG: https://clinicaltrials.gov/ct2/show/NCT02212912]

References to studies excluded from this review

Brady 2015 *{published data only}*

Brady MC, Stott D, Weir CJ, Chalmers C, Sweeney P, Donaldson C, et al. Clinical and cost effectiveness of enhanced

oral healthcare in stroke care settings (SOCLE II): a pilot, stepped wedge, cluster randomized, controlled trial protocol. *International Journal of Stroke* 2015;**10**(6):979-84.

Fousse 2020 *{published data only}*

Fousse M, Grun D Helwig S, Walter S, Bekhit A, Wagenpfeil S, et al. Effects of a feedback-demanding stroke clock on acute stroke management: a randomized study. *Stroke* 2020;**51**(10):2895-900.

Fu 2020 *{published data only}*

Fu S, Han H, Fan C, Jiang Y. Clinical nursing pathway improves the nursing satisfaction in patients with acute cerebral hemorrhage: a randomized controlled trial protocol. *Medicine (Baltimore)* 2020;**99**(44):e22989.

Haesebaert 2016 *{published data only}*

Haesebaert J, Bravant E, Porthault S, Termoz A, Duclos A, Nighoghossian N, et al. Impact of a multi-faceted training program in emergency services on acute stroke intra-hospital management times in the Rhone-Alpes region, France. *Cerebrovascular Diseases* 2016;**41**:311.

Haesebaert 2018 *{published data only}*

Haesebaert J, Nighoghossian N, Mercier C, Termoz A, Porthault S, Derex L, et al. Improving access to thrombolysis and inhospital management times in ischemic stroke: a stepped-wedge randomized trial. *Stroke* 2018;**49**(2):405-11.

Joubert 2015 *{published data only}*

Joubert J, Davis S, Hankey G, Levi C, Olver J, Gonzales G, et al. ICARUSS, the Integrated Care for the Reduction of Secondary Stroke trial: rationale and design of a randomized controlled trial of a multimodal intervention to prevent recurrent stroke in patients with a recent cerebrovascular event, ACTRN = 1261100026498. *International Journal of Stroke* 2015;**10**(5):773-7.

Lakshminarayan 2010 *{published data only}*

Lakshminarayan K, Borbas C, McLaughlin B, Morris NE, Vazquez G, Luepker RV, et al. A cluster-randomized trial to improve stroke care in hospitals. *Neurology* 2010;**74**(20):1634-42.

Machline-Carrion 2018 *{published data only (unpublished sought but not used)}*

Machline-Carrion M, Soares R, Damiani L, Campos V, Sampaio B, Yamashita J, et al. Rationale and design for a cluster randomized quality-improvement trial to increase the uptake of evidence-based therapies for patients at high cardiovascular risk: the BRIDGE-Cardiovascular Prevention Trial. *American Heart Journal* 2018;**207**:40-8.

Middleton 2019 *{published data only}*

Middleton S, Dale S, Cheung NW, Cadilhac DA, Grimshaw J, Levi C, et al, on behalf of T3 Trial Collaborators. Nurse-initiated acute stroke care in emergency departments: the Triage, Treatment, and Transfer Implementation Cluster Randomized Controlled Trial. *Stroke* 2019;**50**(6):1346-55.

NCT00673491 2008 *{published data only}*

NCT00673491. Clinical pathways for effective and appropriate care. Clinicaltrials.gov 2008.

Panella 2008 *{published data only}*

Panella M, Marchisio S, Barbieri A, Di Stanislao F. A cluster randomized trial to assess the impact of clinical pathways for patients with stroke: rationale and design of the Clinical Pathways for Effective and Appropriate Care Study [NCT00673491]. *BMC Health Services Research* 2008;**8**:223.

Panella 2012 *{published data only}*

Panella M, Marchisio S, Brambilla R, Vanhaecht K, Di Stanislao F. A cluster randomized trial to assess the effect of clinical pathways for patients with stroke: results of the Clinical Pathways for Effective and Appropriate Care Study. *BMC Medicine* 2012;**10**:71.

Swartz 2014 *{published data only}*

Swartz RH, Sicard MN, Silver FL, Saposnik G, Gladstone DJ, Breaton J, et al. The CLOQS Trial protocol: a cluster-randomized trial evaluating a simple, low-cost intervention to reduce treatment times in acute stroke. *International Journal of Stroke* 2014;**9**(4):525-8.

Williams 2016 *{published data only}*

Williams L, Daggett V, Slaven JE, Yu Z, Sager D, Myers J, et al. A cluster-randomised quality improvement study to improve two inpatient stroke quality indicators. *BMJ Qual Saf* 2016;**25**:257-64.

References to ongoing studies

Lou 2017 *{published data only}*

Lou M. Improving in-hospital stroke service utilisation in China. ClinicalTrials.gov 2017. [CTG: https://clinicaltrials.gov/ct2/show/NCT03317639]

Additional references

Abraham 2009

Abraham C, Kelly MP, West R, Michie S. The UK National Institute for Health and Clinical Excellence public health guidance on behaviour change: a brief introduction. *Psychology, Health and Medicine* 2009;**14**(1):1-8. [DOI: 10.1080/13548500802537903]

Aho 1980

Aho K, Harmsen P, Hatano S, Marquardsen J, Smirnov VE, Strasser T. Cerebrovascular disease in the community: results of a WHO collaborative study. *Bulletin of the World Health Organization* 1980;**58**(1):113-30. [PMID: PMC2395897]

Badhiwala 2015

Badhiwala JH, Nassiri F, Alhazzani W, Selim MH, Farrokhyar F, Spears J, et al. Endovascular thrombectomy for acute ischemic stroke: a meta-analysis. *JAMA: The Journal of the American Medical Association* 2015;**314**:1832-43. [DOI: doi: 10.1001/jama.2015.13767.]

Birken 2017

Birken SA, Powell BJ, Shea CM, Haines ER, Alexis Kirk M, Leeman J, et al. Criteria for selecting implementation science theories and frameworks: results from an international survey. *Implementation Science* 2017;**12**:124.

Brazier 1992

Brazier JE, Harper NM, Jones A, O'Caithan KJ, Thomas T, Usherwood T, et al. Validating the SF-36 health questionnaire: a new outcome measure for primary care. *BMJ* 1992;**305**:160-4.

Brennan 2009

Brennan S, McKenzie J, Whitty P, Buchan H, Green S. Continuous quality improvement: effects on professional practice and healthcare outcomes. *Cochrane Database of Systematic Reviews* 2009, Issue 4. Art. No: CD003319. [DOI: 10.1002/14651858.CD003319.pub2]

Cadilhac 2004

Cadilhac DA, Ibrahim J, Pearce DC, Ogden KJ, McNeill J, Davis SM, et al, on behalf of the SCOPES Study Group. Multicenter comparison of processes of care between stroke units and conventional care wards in Australia. *Stroke* 2004;**35**(5):1035-40. [DOI: 10.1161/01.STR.0000125709.17337.5d]

Cadilhac 2008

Cadilhac DA, Pearce DC, Levi CR, Donnan GA. Improvements in the quality of care and health outcomes with new stroke care units following implementation of a clinician-led, health system redesign programme in New South Wales, Australia. *Quality and Safety in Health Care* 2008;**17**(5):329-33. [DOI: 10.1136/qshc.2007.024604]

Cadilhac 2013

Cadilhac DA, Moss K, Price C, Lannin N, Lim J, Anderson CA. Pathways to enhancing the quality of stroke care through national data monitoring systems for hospitals. *Medical Journal Australia* 2013;**199**(10):650-1. [DOI: 10.5694/mja14.00044]

Cadilhac 2016

Cadilhac DA, Kim J, Lannin NA, Kapral MK, Schwamm LH, Dennis MS, et al. National stroke registries for monitoring and improving the quality of hospital care: a systematic review. *International Journal of Stroke* 2016;**11**(1):28-40. [DOI: 10.1177/1747493015607523]

Cahill 2020

Cahill LS, Carey LM, Lannin NA, Turville M, Nielson CL, Lynch EA, et al. Implementation interventions to promote the uptake of evidence-based practices in stroke rehabilitation. *Cochrane Database of Systematic Reviews* 2020, Issue 10. Art. No: CD012575. [DOI: 10.1002/14651858.CD012575.pub2]

Campbell 2019

Campbell BCV, De Silva DA, Macleod MR, Coutts SB, Schwamm LH, Davis SM, et al. Ischaemic stroke. *Nature Reviews Disease Primers* 2019;**5**:70.

Cane 2012

Cane J, O'Connor D, Michie S. Validation of the theoretical domains framework for use in behaviour change and implementation research. *Implementation Science* 2012;**7**:37. [DOI: 10.1186/1748-5908-7-37]

Chimatiro 2019

Chimatiro GL, Rhoda AJ. Scoping review of acute stroke care management and rehabilitation in low and middle-income countries. *BMC Health Services Research* 2019;**19**:789.

Craig 2008

Craig P, Dieppe P, Macintyre S, Michie S, Nazareth I, Petticrew M. Developing and evaluating complex interventions: the new Medical Research Council guidance. *BMJ* 2008;**337**:a1655. [DOI: https://doi.org/10.1136/bmj.a1655]

Damschroder 2009

Damschroder LJ, Aron DC, Keith RE, Kirsh SR, Alexander JA, Lowery JC. Fostering implementation of health services research findings into practice:a consolidated framework for advancing implementation science. *Implementation Science* 2009;**4**:50.

Davies 2010

Davies P, Walker A, Grimshaw J. A systematic review of the use of theory in the design of guideline dissemination and implementation strategies and interpretation of the results of rigorous evaluations. *Implementation Science* 2010;**5**(14):5908-15. [DOI: 10.1186/1748-5908-5-14]

Deloitte Access Economics 2020

Deloitte Access Economics. The Economic Impact of Stroke in Australia, 2020. Stroke Foundation, 2020. [URL: www.deloitteaccesseconomics.com.au/uploads/File/Stroke%20Report%2014%20Mar%2013.pdf]

Drury 2014

Drury P, Levi C, D'Este C, McElduff P, McInnes E, Hardy J, et al. Quality in Acute Stroke Care (QASC): process evaluation of an intervention to improve the management of fever, hyperglycemia, and swallowing dysfunction following acute stroke. *International Journal of Stroke* 2014;**9**(6):766-76. [DOI: 10.1111/ijs.12202]

Effective Practice and Organisation of Care 2013a

Effective Practice and Organisation of Care (EPOC). Data collection form. EPOC resources for review authors. epoc.cochrane.org/epoc-specific-resources-review-authors (accessed 2013).

Effective Practice and Organisation of Care 2013b

Effective Practice and Organisation of Care (EPOC). EPOC worksheets for preparing a 'Summary of findings' table using GRADE. EPOC resources for review authors. epoc.cochrane.org/epoc-specific-resources-review-authors (accessed 2013).

Effective Practice and Organisation of Care 2015

Effective Practice and Organisation of Care (EPOC). EPOC taxonomy. epoc.cochrane.org/epoc-taxonomy (accessed 2015).

Effective Practice and Organisation of Care 2016b

Effective Practice and Organisation of Care (EPOC). Suggested risk of bias criteria for EPOC reviews. EPOC resources for review authors. Available from epoc.cochrane.org/epoc-specific-resources-review-authors (accessed 2016).

EuroQoL Group 1990

EuroQoL Group. EuroQoL - a new facility for the measurement of health-related quality of life. *Health Policy* 1990;**16**:199-208.

Evers 2005

Evers S, Goossens M, De Vet H, Van Tulder M, Ament A. Criteria list for assessment of methodological quality of economic evaluations: consensus on health economic criteria. *International Journal of Technology Assessment in Health Care* 2005;**21**(2):240-5. [PMID: 15921065]

Fassbender 2017

Fassbender K, Grotta JC, Walter S, Grunwald IQ, Ragoschke-Schumm A, Saver JL. Mobile stroke units for prehospital thrombolysis, triage and beyond: benefits and challenges. *The Lancet Neurology* 2017;**16**:227-37.

Francke 2008

Francke AL, Smit MC, de Veer AJ, Mistiaen P. Factors influencing the implementation of clinical guidelines for health care professionals: a systematic meta-review. *BMC Medical Informatics and Decision Making* 2008;**8**:38. [DOI: https://doi.org/10.1186/1472-6947-8-38]

GBD 2019 Stroke Collaborators

GBD 2019 Stroke Collaborators. Global, regional, and national burden of stroke and its risk factors, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. *The Lancet Neurology* 2021;**20**:795-820.

Goyal 2016

Goyal M, Menon BK, van Zwam WH, Dippel DW, Mitchell PJ, Demchuk AM, et al, on behalf of HERMES collaborators. Endovascular thrombectomy after large-vessel ischaemic stroke: a meta-analysis of individual patient data from five randomised trials. *Lancet* 2016;**387**:1723-31. [DOI: 10.1016/S0140-6736(16)00163-X.]

GRADEpro GDT [Computer program]

GRADEpro GDT. Version accessed 13 April 2023. Hamilton (ON): McMaster University (developed by Evidence Prime). Available at gradepro.org.

Graham 2006

Graham ID, Logan J, Harrison MB, Straus SE, Tetroe J, Caswell W, et al. Lost in knowledge translation: time for a map? *Journal of Continuing Education in the Health Professions* 2006;**26**(1):13-24. [DOI: 10.1002/chp.47]

Grol 2002

Grol R. Changing physicians' competence and performance: finding the balance between the individual and the organisation. *Journal of Continuing Education in the Health Professions* 2002;**22**(4):244-51. [DOI: 10.1002/chp.1340220409]

Grol 2003

Grol R, Grimshaw J. From evidence to best practice: effective implementation of change in patients' care. *Lancet* 2003;**362**(9391):1225-30. [DOI: 10.1016/S0140-6736(03)14546-1]

Guyatt 2011

Guyatt GH, Oxman AD, Vist G, Kunz R, Brozek J, Alonso-Coello P, et al. GRADE guidelines: 4. Rating the quality of evidence—study limitations (risk of bias). *Journal of Clinical Epidemiology* 2011;**64**(4):407-15. [DOI: https://doi.org/10.1016/j.jclinepi.2010.07.017]

Harvey 2016

Harvey G, Kitson A. PARIHS revisited: from heuristic to integrated framework for the successful implementation of knowledge into practice. *Implementation Science* 2016;**11**:33.

Higgins 2011

Higgins JPT, Alman DG, Sterne JAC. Chapter 8: Assessing risk of bias in a randomized trial. In: Higgins JP, Green S, editor(s). Cochrane Handbook for Systematic Reviews of Interventions Versions 5.1.0 (updated March 2011). The Cochrane Collaboration, 2011. Available from training.cochrane.org/handbook/archive/v5.1/.

Higgins 2022

Higgins JP, Thomas J, Chandler J, Cumpston M, Li T, Page MJ, Welch VA (editors). Cochrane Handbook for Systematic Reviews of Interventions version 6.3 (updated February 2022). Cochrane, 2022. Available from www.training.cochrane.org/handbook edition. John Wiley & sons, 2022.

Intercollegiate Stroke Working Party 2016

Intercollegiate Stroke Working Party. National clinical guideline for stroke. 5th edition. London: Royal College of Physicians, 2016.

Ivers 2014

Ivers N, Sales A, Colquhoun H, Michie S, Foy R, Francis J, et al. No more 'business as usual' with audit and feedback interventions: towards an agenda for a reinvigorated intervention. *Implementation Science* 2014;**9**:14. [DOI: https://doi.org/10.1186/1748-5908-9-14]

Johnson 2015

Johnson M, May C. Promoting professional behaviour change in healthcare: what interventions work, and why? A theory-led overview of systematic reviews. *BMJ Open* 2015;**5**(9):e008592. [DOI: http://dx.doi.org/10.1136/bmjopen-2015-008592]

King's College London 2020

King's College London. Sentinel Stroke National Audit Programme. www.strokeaudit.org [accessed December 2020]. [URL: www.rcplondon.ac.uk/projects/outputs/national-sentinel-stroke-audit-2008]

Kwan 2002

Kwan J, Sandercock PAG. In-hospital care pathways for stroke. *Cochrane Database of Systematic Reviews* 2002, Issue 2. Art. No: CD002924. [DOI: 10.1002/14651858.CD002924]

Langhorne 2018

Langhorne P, Collier JM, Bate PJ, Thuy MNT, Bernhardt J. Very early versus delayed mobilisation after stroke. *Cochrane Database of Systematic Reviews* 2018, Issue 10. Art. No: CD006187. [DOI: 10.1002/14651858.CD006187.pub3]

Langhorne 2020

Langhorne P, Ramachandra S. Organised inpatient (stroke unit) care for stroke: network meta-analysis. *Cochrane Database of Systematic Reviews* 2020, Issue 4. Art. No: CD000197. [DOI: 10.1002/14651858.CD000197.pub4]

Lindsay 2014

Lindsay P, Furie KL, Davis SM, Donnan GA, Norrving B. World Stroke Organization Global Stroke Services guidelines and action plan. *International Journal of Stroke* 2014;**Suppl A100**:4-13. [DOI: https://doi.org/10.1111/ijs.12371]

Lynch 2018

Lynch EA, Mudge A, Knowles S, Kitson AL, Hunter SC, Harvey G. "There is nothing so practical as a good theory": a pragmatic guide for selecting theoretical approaches for implementation projects. *BMC Health Services Research* 2018;**18**:857.

May 2009

May C, Finch T. Implementing, embedding, and integrating practices: anoutline of normalization process theory. *Sociology* 2009;**43**(3):535-54.

Melnychuk 2019

Melnychuk M, Morris S, Black G, Ramsay AIG, Eng J, Rudd A, et al. Variation in quality of acute stroke care by day and time of admission: prospective cohort study of weekday and weekend centralised hyperacute stroke unit care and non-centralised services. *British Medical Journal Open* 2019;**9**:e025366. [DOI: doi:10.1136/ bmjopen-2018-025366]

Menon 2009

Menon A, Korner-Bitensky N, Kastner M, McKibbon KA, Straus S. Strategies for rehabilitation professionals to move evidence-based knowledge into practice: a systematic review. *Journal of Rehabilitation Medicine* 2009;**41**(13):1024-32. [DOI: 10.2340/16501977-0451]

Meretoja 2013

Meretoha A, Weir L, Ugalde M, Yassi N, Yan B, Hand P, et al. Helsinki model cut stroke thrombolysis delays to 25 minutes in Melbourne in only 4 months. *Neurology* 2013;**81**:1071-6.

Michie 2011

Michie S, van Stralen MM, West R. The behaviour change wheel: a new method for characterising and designing behaviour change interventions. *Implementation Science* 2011;**6**:42.

Moher 2009

Moher D, Liberati A, Tetzlaff J, Altman DG, on behalf of The PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *British Medical Journal* 2009;**6**(7):e1000097. [DOI: https://doi.org/10.1371/journal.pmed.1000097]

NHMRC 2009

NHMRC GAR consultants. NHMRC levels of evidence and grades for recommendations for developers of guidelines: December 2009. Available at https://www.nhmrc.gov.au/sites/default/files/images/NHMRC%20Levels%20and%20Grades%20(2009).pdf.

Nilsen 2015

Nilsen, P. Making sense of implementation theories, models and frameworks. *Implementation Science* 2015;**10**:53. [DOI: https://doi.org/10.1186/s13012-015-0242-0]

Pinnock 2017

Pinnock H, Barwick M, Carpenter CR, Eldridge S, Grandes G, Griffiths CJ, et al. Standards for Reporting Implementation Studies (StaRI) statement. *British Medical Journal* 2017;**356**:i6795.

Powers 2019

Powers WJ, Rabinstein AA, Ackerson T, Adeoye OM, Bambakidis NC, Becker K, et al, on behalf of the American Heart Association Stroke Council. Guidelines for the early management of patients with acute ischemic stroke: 2019 update to the 2018 guidelines for the early management of acute ischemic stroke: a guideline for healthcare professionals from the American Heart Association/American Stroke Association. *Stroke* 2019;**50**(12):e344-e418. [DOI: https://doi.org/10.1161/STR.0000000000000211]

Redfern 2006

Redfern J, McKevitt C, Wolfe C. Development of complex interventions in stroke care: a systematic review. *Stroke* 2006;**37**(9):2410-9. [DOI: 10.1161/01.STR.0000237097.00342.a9]

RevMan 2014 [Computer program]

Review Manager 5 (RevMan 5). Version 5.3. Copenhagen: The Cochrane Collaboration, 2014.

Sacco 2013

Sacco RL, Kasner SE, Broderick JP, Caplan LR, Connors JJ, Culebras A, et al, on behalf of the American Heart Association Stroke Council, Council on Cardiovascular Surgery and Anesthesia, Council on Cardiovascular Radiology and Intervention, Council on Cardiovascular and Stroke Nursing, Council on Epidemiology and Prevention, Council on Peripheral Vascular Disease, Council on Nutrition, Physical Activity and Metabolism. An updated definition of stroke for the 21st century: a statement for healthcare professionals from the American Heart Association/American Stroke Association. *Stroke* 2013;**44**(7):2064-89. [DOI: 10.1161/STR.0b013e318296aeca]

Salinas 2016

Salinas J, Sprinkhuizen SM, Ackerson T, Bernhardt J, Davie C, George MG, et al. An international standard set of patient-centered outcome measures after stroke. *Stroke* 2016;**47**:180-6.

Sandercock 2014

Sandercock PA, Counsell C, Tseng MC, Cecconi E. Oral antiplatelet therapy for acute ischaemic stroke. *Cochrane*

Database of Systematic Reviews 2014, Issue 3. Art. No: CD000029. [DOI: 10.1002/14651858.CD000029.pub3]

Schunemann 2022

Schunemann HJ, Higgins JPT, Vist GE, Glasziou P, Akl EA, Skoetz N, et al, on behalf of the Cochrane GRADEing Methods Group (formerly Applicability and Recommendations Methods group) and the Cochrane Statistical Methods Group. Chapter 14: Completing 'Summary of findings' tables and grading the certainty of the evidence. In: Higgins JP, Thomas J, Chandler J, Cumpston M, Li T, Page MJ, Welch VA (editors). Cochrane Handbook for Systematic Reviews of Interventions version 6.3 (updated February 2022). Cochrane, 2022.

Sims 2010

Sims NR, Muyderman H. Mitochondria, oxidative metabolism and cell death in stroke. *Biochimica et Biophysica Acta* 2010;**1802**(1):80-91. [DOI: 10.1016/j.bbadis.2009.09.003]

Skolarus 2017

Skolarus TA, Lehmann T, Tabak RG, Harris J, Lecy J, Sales AE. Assessing citation networks for dissemination and implementation of research frameworks. *Implementation Science* 2017;**12**:97.

Squires 2014

Squires JE, Sullivan K, Eccles MP, Worswick J, Grimshaw JM. Are multifaceted interventions more effective than single-component interventions in changing health-care professionals' behaviours? An overview of systematic reviews. *Implementation Science* 2014;**9**:152. [DOI: https://doi.org/10.1186/s13012-014-0152-6]

Stroke Foundation 2021

Stroke Foundation. National Stroke Audit - Acute Services Report 2021. Melbourne, Australia: Stroke Foundation; 2021. [URL: informme.org.au/stroke-data]

Stroke Foundation 2022

Stroke Foundation. Clinical guidelines for stroke management. https://informme.org.au/Guidelines/Clinical-Guidelines-for-Stroke-Management (accessed 2022).

Ting 2007

Ting HH, Rihal CS, Gersh BJ, Haro LH, Bjerke CM, Lennon RJ, et al. Regional systems of care to optimize timeliness of reperfusion therapy for ST-elevation myocardial infarction. The Mayo Clinic STEMI Protocol. *Circulation* 2007;**116**(7):729-36. [DOI: 10.1161/CIRCULATIONAHA.107.699934]

Ukoumunne 1999

Ukoumunne OC, Guilliford MC, Chinn S, Sterne JA, Burney PG. Methods for evaluating area-wide and organisation-based interventions in health and health care: a systematic review. *Health Technology Assessment* 1999;**3**:iii-92. [PMID: 10982317]

Urimubenshi 2017

Urimubenshi G, Langhorne P, Cadilhac DA, Kagwiza JN, Wu O. Association between patient outcomes and key performance indicators of stroke care quality: a systematic review and meta-analysis. *European Stroke Journal* 2017;**4**:287-307. [DOI: 10.1177/2396987317735426]

Wardlaw 2014

Wardlaw JM, Murray V, Berge E, del Zoppo GJ. Thrombolysis for acute ischaemic stroke. *Cochrane Database of Systematic Reviews* 2014, Issue 7. Art. No: CD000213. [DOI: 10.1002/14651858.CD000213.pub3]

References to other published versions of this review

Luker 2017

Luker JA, Bernhardt J, Graham ID, Middleton S, Lynch EA, Thayabaranathan T, et al. Interventions for the uptake of evidence-based recommendations in acute stroke settings. *Cochrane Database of Systematic Reviews* 2017, Issue 1. Art. No: CD012520. [DOI: 10.1002/14651858.CD012520]

* Indicates the major publication for the study

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Dirks 2011

Study characteristics	
Methods	**Study design:** cluster-randomised trial
Participants	**Intervention scope:** hospitals with stroke teams or units at multiple (12) hospitals. **Health professionals:** stroke teams participating in the Breakthrough program for improving organised stroke care in the Netherlands **Patients:** 5515 (1657 ischaemic stroke patients admitted < 4 h after onset included for analysis – 880 in intervention group, 777 in control group); 50% male, mean age 72 years, 85% ischaemic stroke, median National Institutes of Health Stroke Scale 8

Dirks 2011 *(Continued)*

	Size of acute stroke unit (no. of patients admitted per year): median 332 and 264 stroke patients in intervention and control hospitals, respectively **Urban, metropolitan or rural setting:** urban and metropolitan **Public or private health insurance funding:** mixed public and private funding – 2 known public hospitals, 3 known private hospitals **Socioeconomic characteristics of setting (social advantage/disadvantage):** mixed advantaged and disadvantaged areas – 3 hospitals in disadvantaged socioeconomic area, 2 hospitals in advantaged socioeconomic area
Interventions	**Intervention characteristics** *Promoting Acute Thrombolysis for Ischaemic Stroke (PRACTISE)* • Local teams formed containing stroke neurologist and stroke nurse • Teams asked to note local barriers to further implementation in their hospital, to set goals and to plan actions to reach these goals • Intervention continued for 2 years, comprised 5 half-day intervention meetings and 1 closing session (6 group training sessions of 4 to 5 h) • An internet-based tool kit consisting of presentations, checklists, papers and revised protocols made available to the local team **Control** • No details provided. Nurses and paramedical personnel were told that the hospital was participating in a project to register and enhance the rate of thrombolysis. **Aim of intervention** • Decrease and resolve potential treatment barriers to thrombolysis for participants with acute stroke • Increase proportion of participants with acute stroke treated with thrombolysis
Outcomes	Data collected by trained local hospital personnel not involved in patient treatment **Primary outcomes** • Treatment with thrombolysis (all participants with stroke) during hospital admission • Treatment with thrombolysis during hospital admission in participants with ischaemic stroke admitted within 4 h of symptom onset **Secondary outcomes** • Admission within 4 h of symptom onset • Death or disability (mRS < 3) at 3 months in people with ischaemic stroke admitted within 4 h of symptom onset • Quality of life (EuroQol) at 3 months in people with ischaemic stroke admitted within 4 h of symptom onset T**ertiary outcomes** • Onset-to-door time (all participants with stroke) • Onset-to-door time in people with ischaemic stroke admitted within 4 h of symptom onset • Door-to-needle time in participants with ischaemic stroke admitted within 4 h of symptom onset
Identification	**Sponsorship source:** This study was funded by the Netherlands Organisation for Health Research and Development (ZON-MW, grant number 945-14-217). ZON-MW is the national health council appointed by the Ministry of Health (VWS) and the Netherlands Organisation for Scientific Research (NWO) to promote quality and innovation in the field of health research and care. **Country:** the Netherlands

Dirks 2011 *(Continued)*

Setting: 12 hospitals (urban and community, academic and nonacademic) – Academisch Ziekenhuis Maastricht, Spaarne ziekenhuis Hoofddorp, Rijnstate ziekenhuis, Medisch Spectrum Twente, Meander Medisch Centrum, Atrium Medisch Centrum, Catharina ziekenhuis, Ziekenhuis Rivierenland, Erasmus Medisch Centrum, Amphia ziekenhuis, Sint Franciscus ziekenhuis, IJsselmeer ziekenhuizen

Declarations of interest: none declared

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Notes	This trial did not specify how many patients were included from stroke units; however, 11 of 12 participating hospitals had a stroke unit and met the ≥ 70% stroke unit participation criteria.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"The 12 hospitals that agreed to participate were assigned to the regular intensity or high-intensity intervention by random allocation after pair-wise matching. The pairing was based on the thrombolysis rate, the number of patients admitted with an ischaemic stroke in the year 2003 and hospital type (regional vs. urban, and academic vs. nonacademic) in reverse order. Randomisation was performed with a table of random numbers, presented in pairs, by a statistician who was otherwise not involved in the study, and who was blind to the identity of the hospitals."
Allocation concealment (selection bias)	Low risk	"Randomisation was performed with a table of random numbers, presented in pairs, by a statistician who was otherwise not involved in the study, and who was blind to the identity of the hospitals."
Blinding of participants and personnel (performance bias) All outcomes	High risk	"Local neurologists and paramedical personnel in intervention hospitals were aware that they participated in a program to enhance the rate of thrombolysis. Their colleagues in the control hospitals were only notified that they participated in a registration project."
Blinding of outcome assessment (detection bias) All outcomes	Low risk	"Trained, local personnel not involved in the patient's treatment collected the data, which were entered into Web-based forms. The central trial office provided the 3-month follow-up assessment and used simple questions to record the patient's dependency and health-related quality of life. The 2 researchers who assessed outcome data were blinded to the intervention assignment."
Incomplete outcome data (attrition bias) All outcomes	Low risk	The primary outcome is treatment with thrombolysis, which has complete data. Similar numbers of participants lost to follow-up at 3 months (35 (4.5%) control, 29 (3.3%) in intervention).
Selective reporting (reporting bias)	Low risk	All outcomes reported in the protocol are presented
Other bias	Low risk	No other risks of bias identified (low risk of selective recruitment, protected against contamination, baseline patient characteristics were similar between groups, outcome measures at baseline were similar between groups)

Levi 2020

Study characteristics	
Methods	**Study design:** cluster-randomised trial
Participants	**Intervention scope:** 20 hospitals with stroke units in 3 states of Australia **Health professionals:** staff in paramedicine, emergency, stroke care and imaging (radiography) **Patients:** 6276 (3160 in intervention group, 3116 in control group); acute stroke; 54% male, mean age 71 years, ischaemic stroke only, median National Institutes of Health Stroke Scale 11 **Urban, metropolitan or rural setting:** metropolitan and regional hospitals **Public or private health insurance funding:** both public and private hospitals meeting eligibility criteria included **Socioeconomic characteristics of setting (social advantage/disadvantage):** not mentioned
Interventions	**Intervention characteristics** Seven intervention components were delivered over 16 months via a suite of activities; control sites received no implementation support. Preworkshop meetings: • meetings with member(s) of research team and hospital administration • meetings with member(s) of research team and site champion (usually lead nurse and lead clinician) Collaborative communal workshops: • 2 face-to-face workshops with research team (situational analysis, performance feedback, motivation from primary change agent, information-based target setting, intersite collaborative problem setting and professional development of champion skills) Site-based working groups: • 1 site meeting with working group and research team (situational analysis, motivation via change agents, information-based target setting and intersite collaborative problem-solving) • regular site meetings: action planning, performance monitoring and intrasite problem-solving Web-based training modules: • for all staff involved in stroke care for professional development in clinical decision-making re thrombolysis Regular telephone case monitoring: • research team member(s) contacted site champion to monitor performance regarding decision and outcomes for thrombolysed cases Bimonthly feedback of proportions of participants with ischaemic stroke receiving thrombolysis (provided 5 times): • comparative feedback to members of each site working group Bimonthly intersite teleconferences: • with member/s of research team and site representatives (intersite collaborative problem-solving) **Aim of intervention**

Levi 2020 *(Continued)*

	To increase the proportion of patients with ischaemic stroke receiving thrombolysis while maintaining accepted benchmarks for low rates of intracranial haemorrhage and high rates of functional outcomes at 3 months
Outcomes	Data on patients treated with tPA were entered by stroke unit staff into a secure, purpose-built online audit tool as part of each unit's routine stroke thrombolysis audit procedure. **Primary outcome** • Proportion of stroke cases in each hospital that were treated with tPA during hospital admission within each month **Secondary outcomes** • Proportion of patients treated with IVT during hospital admission who experienced favourable 3-month outcomes (mRS score 0 to 1) • Proportion of patients treated with IVT who experienced symptomatic intracranial haemorrhage during hospital admission
Identification	**Sponsorship:** This study was funded by a National Health and Medical Research Council Partnership Grant (569328), partially funded by a National Health and Medical Research Council Practitioner Fellowship (1043913) and National Health and Medical Research Translating Research into Practice Fellowship and included Partnership Grant contribution funding from Boehringer Ingelheim, in-kind support from the Agency for Clinical Innovation Stroke Care Network/Stroke Services New South Wales, the National Stroke Foundation and New South Wales Cardiovascular Research Network-National Heart Foundation, with cash contribution from the Victorian Stroke Clinical Network and infrastructure funding from Hunter Medical Research Institute and The University of Newcastle. **Country**: Australia **Setting:** 20 Australian hospitals, across 3 states (4 Victoria, 3 Queensland, 13 New South Wales) **Declarations of interest:** Sanson-Fisher, Levi, Paul, D'Este, Parsons, Bladin, Lindley and Attia declare the receipt of support from the following third parties: National Health and Medical Research Council grant **First author's name:** Christopher R. Levi **Institution:** The University of New South Wales **Email:** christopher.levi@unsw.edu.au **Address:** Department of Neurology, John Hunter Hospital, Lookout Rd, New Lambton Heights, New South Wales, Australia
Notes	Additional data requested from authors re comparison of secondary outcomes between groups that were not available in manuscript

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Randomisation of hospitals to intervention or control was performed as a single event by a statistician
Allocation concealment (selection bias)	Unclear risk	Not described
Blinding of participants and personnel (performance bias)	High risk	Personnel were not blinded to intervention

Levi 2020 *(Continued)*

All outcomes		
Blinding of outcome assessment (detection bias) All outcomes	High risk	Data collected and entered by stroke unit staff at participating hospitals
Incomplete outcome data (attrition bias) All outcomes	Low risk	All hospitals completed trial, data collected as part of routine data collection, so no patients dropped out
Selective reporting (reporting bias)	Low risk	Outcomes reported adhere to published protocol
Other bias	Low risk	No other risks of bias identified (low risk of selective recruitment, protected against contamination, baseline patient characteristics were similar between groups, outcome measures at baseline were similar between groups)

Lynch 2016

Study characteristics	
Methods	**Study design:** cluster-randomised trial **Study grouping:**allocation by hospital
Participants	**Intervention scope:** stroke units at multiple (ten) hospitals. Eight hospitals with stroke units included in analysis. **Health professionals:** multidisciplinary stroke rehabilitation team - medical professionals, nurses, physiotherapists, occupational therapists, speech pathologists, psychologists, dieticians and social workers. **Patients:** 586 (284 pre-intervention, 302 post-intervention); acute stroke patients; 57% Male, mean age 77.5, years 88% ischaemic stroke, median National Institutes of Health Stroke Scale not presented, but 8<. **Type of acute stroke unit:** all acute intensive stroke units: continuous monitoring, high nurse staffing levels, potential for life support **Size of acute stroke unit (no. of patients admitted per year):** 1460 patients in 4 hospitals for the multifaceted/intervention sites; 1600 to 1620 patients in 4 hospitals for the education/comparator sites. **Number of beds allocated to stroke:** 28 beds in 4 hospitals for multifaceted/intervention sites; 66 beds in 4 hospitals for education/comparator sites. **Urban, metropolitan or rural setting:** metropolitan.
Interventions	**Intervention characteristics** *Multifaceted Assessment for Rehabilitation Tool (ART) education and support* • *Education sessions*: two education sessions delivered onsite to acute stroke unit team by research physiotherapist (>10 years clinical experience). Both education sessions (duration 30 minutes to 60 minutes) held within a 1-month period, participants were invited to attend both sessions. Education regarding ART (rationale for use, how to use) provided. Up to 3 additional education sessions provided if this was nominated as a strategy by participants in the strategy development workshop • *Printed educational material*: paper copies of the ART, and 3 copies of ART user manual provided to acute stroke unit teams. Information provided regarding freely available associated electronic resources

Lynch 2016 *(Continued)*

- *Audit and feedback*: Medical record audit conducted by research physiotherapist, site-specific feedback provided verbally and written (paper-version) summary of audit distributed to participants working on acute stroke unit by research physiotherapist on proportions of patients assessed for rehabilitation, profiles of patients not assessed in audit, profiles of professionals who conducted the assessments in the audit, summary of assessment processes and access to rehabilitation
- *Barrier identification and strategy development*: Workshops held with acute stroke unit team at each site (facilitated by research physiotherapist) to identify barriers to use of ART, followed immediately by strategy development session (combined session 60-minute duration)
- *Site Champions*: each site nominated 1-3 site champions to lead implementation of strategies developed in workshop
- *Reminders*: 1 or 2 emails sent to all workshop participants by research physiotherapist regarding strategies developed to use ART. Monthly phone or email contact between research physiotherapist and site champion for 4 months following initial education session (more contact if initiated by site champion) to discuss implementation of strategies

ART education only

- *Education sessions*: Education session (1 only, 30 minute duration) delivered onsite to acute stroke unit team by research physiotherapist (>10 years clinical experience). Education regarding ART (rationale for use, how to use) provide.
- *Printed educational material*: Paper copies of the ART, and 3 copies of ART user manual provided to acute stroke unit teams. Information provided regarding freely available associated electronic resource

Aim of intervention:

- Increase rehabilitation assessment practices by health professionals working with patients with stroke

Outcomes	Data collected through chart audit by a blinded data collector. **Primary outcome** • Assessment for rehabilitation documented during hospital admission **Secondary outcome** • Criteria used in documented assessment for rehabilitation
Identification	**Sponsorship source:** The research was supported by grants from the National Stroke Foundation and The New South Wales Agency for Clinical Innovation. EAL is a recipient of an Australian Postgraduate Award Scholarship and University of South Australia Top-up Research Scholarship; JAL holds a National Health and Medical Research Council (NHMRC) Australian Research early Career Fellowship (RGMS ID APP1052524). DAC is supported by an NHMRC Fellowship co-funded with the Heart Foundation (1063761). **Country:** Australia **Setting:** ten hospitals in South Australia and New South Wales **Declarations of interest:** N none declared **First author's name:** Dr Elizabeth Lynch **Institution:** University of South Australia **Email:** elizabeth.lynch@unisa.edu.au **Address:** University of South Australia, GPO Box 2471, Adelaide, 5001
Notes	All hospitals in South Australia with organised stroke services were eligible to participate in the trial. Hospitals in other states of Australia with acute stroke units, admitting more than 100 patients with stroke were also eligible.

Lynch 2016 *(Continued)*

First author was contacted and provided unpublished data: data collected from acute stroke units only.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Recruited hospitals were stratified by state, region (metropolitan, regional) and the proportion of patients that had their rehabilitation needs assessed in the 2011 national audit. After stratification, hospitals were randomly assigned to receive either an education-only intervention or a multifaceted intervention. The randomisation schedule was generated by computer program on 19/3/2013 by a third party, blind to the specific hospital list."
Allocation concealment (selection bias)	Low risk	"Allocation was then undertaken by assigning the coded hospitals to the list based on the stratification."
Blinding of participants and personnel (performance bias) All outcomes	High risk	Not reported, but staff must be aware of the ART intervention in order to implement changes.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	"Medical records were audited by assessors blinded to group allocation before and after the implementation period."
Incomplete outcome data (attrition bias) All outcomes	Low risk	No missing data.
Selective reporting (reporting bias)	Low risk	All outcomes detailed in the trial registration are reported.
Other bias	Unclear risk	No other risks of bias identified (low risk of selective recruitment, protected against contamination), but it is unclear if baseline patient characteristics were similar between groups and outcome measures at baseline were similar between groups.

Middleton 2011

Study characteristics

Methods	**Study design: c**luster-randomised trial **Study grouping:** allocation by hospital
Participants	**Intervention scope:** stroke units at multiple (19) hospitals. **Health professionals:** stroke team members - including nurses, stroke unit coordinators, speech pathologists, physicians. **Patients:** 1696 (687 pre-intervention, 1009 post-intervention); acute stroke patients; 60% male, mean age not presented but between 65-74, 95% ischaemic stroke, National Institutes of Health Stroke Scale not measured. **Type of acute stroke unit:** 18 acute intensive stroke units, 1 comprehensive stroke unit. **Size of acute stroke unit (no. of patients admitted per year):** 740-790 patients/year in two known control hospitals; 500-550 patients/year in two known intervention hospitals.

Middleton 2011 *(Continued)*

Number of beds allocated to stroke: 66 beds in 10 known control hospitals; 39 beds and 55 mixed neurology/general ward/stroke ward beds in 9 known intervention hospitals.

Urban, metropolitan or rural setting: urban and metropolitan - 15 urban (6 control group, 9 intervention group) and 4 metropolitan.

Public or private health insurance funding: public hospitals

Socioeconomic characteristics of setting (social advantage/disadvantage): mixed advantaged and disadvantaged areas - 11 hospitals in disadvantaged socioeconomic areas (7 control group, 4 intervention group), 5 hospitals in advantaged socioeconomic areas (1 control group, 4 intervention group), 3 hospitals in mixed socioeconomic areas (1 control group, 2 intervention group).

Interventions	**Intervention characteristics** *Managing fever, hyperglycaemia and dysphage in acute stroke: The Quality in Acute Stroke Care (QASC) Trial* • *Barrier identification*: Two multidisciplinary team-building workshops to identify local barriers and enablers to implement the fever, sugar and swallowing dysfunction (FeSS) nurse-initiated treatment protocols • *Reinforcement of multidisciplinary teamwork*: Two multidisciplinary team-building workshops to identify local barriers and enablers to implement the FeSS nurse-initiated treatment protocols • *Local adaptation* • *Use of site champions*: Engagement of local stroke unit coordinators through support and feedback. Research team member also responded to any site-based request for support if needed • *Clinical treatment protocols for fever, sugar swallowing*: Using recommendations from Australia's national clinical guidelines for stroke, panels of experts developed clinical treatment protocols for management of fever, hyper-glycaemia and swallowing for the first 72 hours after ASU admission • *Educational outreach meetings*: Two site-based educational outreach meetings consisting of a standardised education program about the FeSS treatment protocols delivered by the project officer; Microsoft Powerpoint slides were left with the ASU nurse educator to be delivered to those who did not attend the meetings • *Reminders*: The Project Officer visited each intervention ASU every 6 weeks, sent three monthly proactive emails to each site, and also instigated scheduled telephone follow-up every 3 months; all acted as reminders **Control** • Control ASUs receive an abridged version of the latest National Stroke Foundation Guidelines for Acute Stroke Management Aim of intervention: • Increase adherence to evidence-based management of fever, hyperglycaemia and swallowing dysfunction in patients after acute stroke
Outcomes	Data collected through chart audit by blinded data collectors: **Primary outcome**s • Death or dependency (dependency: modified Rankin Scale ≥2) at 90 days • Functional dependency (Barthel index) at 90 days • Mean SF-36 mental component summary score at 90 days • Mean physical component summary score at 90 days Secondary outcomes • Mean temperature for the first 72 hours after acute stroke unit (ASU) admission • Mean finger-prick blood glucose for the first 72 hours after ASU admission • Proportion with swallowing screening undertaken within the first 24 hours of stroke unit admission

Middleton 2011 *(Continued)*

- Diagnosis of aspiration pneumonia at discharge
- Length of hospital stay

Identification	**Sponsorship source:** this study was funded by the National Health Medical Research Council (NHMRC: 353803), St Vincent's Clinic Foundation, the Curran Foundation, Australian Diabetes Society-Servier, the College of Nursing, and Australian Catholic University.The sponsors of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. **Country:** Australia. **Setting:** ninetee19 New South Wales hospitals. **Declarations of interest: n**one declared **First author's name:** Sandy Middleton **Institution:** Nursing Research Institute, Australian Catholic University **Email:** sandy.middleton@acu.edu.au **Address:** Nursing Research Institute, St Vincent's Mater Health Sydney and School of Nursing (NSW and ACT), Australian Catholic University, NSW, Australia
Notes	Principal investigator and statistician was contacted for unpublished data: swallow screening and paracetamol administration during admission.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"ASUs were stratified by category (category A or B) and then by absolute numbers of pre-intervention cohort patients recruited (high or low recruiters). High recruiters had consented more than two patients per month; low recruiters two or fewer per month. De-identified stratification details were provided to an independent statistician who used random number generating software to randomise withinstrata with allocation concealed until provided to the Project Officer who assigned ASUs to their groups."
Allocation concealment (selection bias)	Low risk	"De-identified stratification details were provided to an independent statistician who used random number generating software to randomise within strata with allocation concealed until provided to the Project Officer who assigned ASUs to their groups."
Blinding of participants and personnel (performance bias) All outcomes	High risk	"Clinical research assistants [personnel] masked to trial design enrolled patients. Patients were masked to ASU group allocation but clinicians delivering our intervention were not."
Blinding of outcome assessment (detection bias) All outcomes	Low risk	"Research assistants who undertook the computer-assisted telephone interviews and the medical record audits were masked to trial aims, design, and group allocation; the trial statistician was masked to group allocation [outcome assessors]."
Incomplete outcome data (attrition bias) All outcomes	Low risk	"Of the 1861 eligible QASC consenting patients across the entire study period, medical records were unavailable for 57 patients (3·6%) [17 (2·4%) from the preintervention cohort and 40 (3·7%) from the postintervention cohort] resulting in collection of data for 1804 patients. No data missing, pre-determined outcomes were assessed." Participant drop out explained in figure 2. Less than 20% drop out rate in each intervention is low risk of bias.

Middleton 2011 *(Continued)*

Selective reporting (reporting bias)	Low risk	All outcomes were reported.
Other bias	Unclear risk	Low risk of selective recruitment, protected against contamination, baseline patient characteristics were similar between groups. Unclear whether outcome measures at baseline were similar between groups (Outcome measures are reported for pre-intervention audited participants - however, this is an overall baseline, and not separated into intervention and control group hospitals.)

Power 2014

Study characteristics	
Methods	**Study design:** cluster-randomised trial **Study grouping:** allocation by hospital
Participants	**Intervention scope:** stroke units at multiple (10) hospitals. **Health professionals:** stroke team members - including radiographers, stroke co-ordinators, nurses, occupational therapists, physiotherapists, healthcare assistants, data collection staff, physicians, ward managers. **Patients:** 7920 (6592 analysed - 3533 in intervention group, 3059 in control group); stroke patients; sex of participants not presented, mean age not presented, % ischaemic stroke not presented, National Institutes of Health Stroke Scale not presented. **Size of acute stroke unit (no. of patients admitted per year):** analysed intervention group hospitals: 544, analysed control group hospitals: 483. **Number of beds allocated to stroke:** average 27 beds in both analysed intervention and control group hospitals. **Urban, metropolitan or rural setting:** urban. **Public or private health insurance funding:** public hospitals. **Socioeconomic characteristics of setting (social advantage/disadvantage):** less advantaged.
Interventions	**Intervention Characteristics** *Stroke 90:10 quality improvement project* • Establishment of an executive leader, physician leader, site leader and project team from clinical and ward areas • Two one-day learning sessions on theory and practice of quality improvement • Executive mentoring visits and two meetings between the project director, hospital chief executive and project team to review progress • Direct access to the Stroke 90:10 project director • Support from an improvement advisor and web-based portal (extranet) improvement advisor • Weekly online sharing and learning sessions **Control** • Usual care Aim of intervention:

Power 2014 *(Continued)*

	• Increase adherence to evidence-based bundles of care on early hours and rehabilitation care of people with stroke
Outcomes	Data collected through chart audit by unblinded data collectors - project staff for control sites, intervention hospitals for their own sites: **Primary outcomes** • Compliance with "early hours" Bundle 1 within 24 hours of admission: Composite of 4 quality of care outcomes (brain scan, aspirin, swallow screen, weight assessment) • Compliance with "rehabilitation" Bundle 2 during hospital admission: Composite of 5 quality of care outcomes (spend at least 50% of admission on stroke unit, assessed by physiotherapist within 72 hours of admission, assessed by occupational therapist within 4 days of admission, mood screen during inpatient stay, documented goal-setting between patient, family and multidisciplinary team. NOTE: Rehabilitation Bundle not included in this review, instead is included in Review by Cahill 2020)
Identification	**Sponsorship source:** DC, MPT and IC's work on Stroke 90:10 was funded by The Health Foundation (MPT was subcontracted from Salford Royal NHS Foundation Trust and IC and DC continue to be employees of Salford Royal NHS Foundation Trust). MPT is named as an applicant on a grant awarded as part of the Health Foundation's Safer Clinical Systems program. **Country:** United Kingdom. **Setting:** ten National Health Service hospital trusts in Northwest England. **Declarations of interest:** All authors have completed the Unified Competing Interest form at www.icmje.org/coi_disclosure.pdf (available on request from the corresponding author) and declare: DC, MPT and IC's work on Stroke 90:10 was funded byThe Health Foundation (MPT was subcontracted from Salford Royal NHS. **Authors name:** Maxine Power **Institution:** Salford Royal NHS Foundation Trust **Email:** maxine.power@nhs.net **Address:** Salford Royal NHS Foundation Trust, Stott Lane, Salford, M6 8HD, England
Notes	All NHS hospital Trusts in the Northwest of England were invited to participate based on the pre-defined inclusion criteria of: a minimum of ten inpatient dedicated stroke beds (a 'stroke unit'); agreement to participate signed by the chief executive; agreement to participate from a consultant in stroke medicine (or equivalent); a dedicated multidisciplinary stroke team; and availability of case notes for review.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"We used a stratified-randomization approach. Hospitals were stratified by stroke performance (Sentinel Audit score above or below 60) in the 12 months preceding baseline data collection (2007 and 2008). Within each group, a computer-generated list was used to randomly allocate 12 hospitals to the intervention group and 12 to the control group."
Allocation concealment (selection bias)	Unclear risk	Not reported.
Blinding of participants and personnel (performance bias) All outcomes	High risk	"The nature of the trial meant that participants could not be blinded to group allocation."

Power 2014 *(Continued)*

Blinding of outcome assessment (detection bias) All outcomes	High risk	Outcome data were collected by intervention teams at intervention sites (who were not blinded), and by Quality Improvement Collaborative faculty at control sites (who must be aware that they collected from control sites).
Incomplete outcome data (attrition bias) All outcomes	High risk	23% of patients allocated to control group hospitals were not included in analysis vs. 11% of participants allocated to intervention group hospitals not included in analysis - >20% drop out or exclusion from analysis is a significant exclusion
Selective reporting (reporting bias)	Low risk	The research protocol was retrospectively registered - all planned outcomes are reported. The outcome measures align with outcomes collected in National Audit.
Other bias	Unclear risk	Low risk of selective recruitment of participants, protected against contamination, intervention and control group characteristics similar at baseline. Unclear whether outcome measures were similar at baseline between groups - data from the last 3 months of the baseline period is reported for the intervention and control hospitals (Table 3), but the groups are not compared.

Shrubsole 2018

Study characteristics	
Methods	Cluster-randomised trial Four acute SLT teams were randomly assigned to receive either Intervention A (targeted at improving information provision) or Intervention B (targeted at improving collaborative goal setting), and were blinded to their allocation. Interventions were tailored to address known barriers and included a face-to-face workshop incorporating behaviour-change techniques.
Participants	Clusters were SLT departments within 4 hospitals. Health professional participants: SLT teams from acute hospitals from Queensland and New South Wales, Australia, were eligible to participate if there was at least one SLT providing management to people with acute post-stroke aphasia; each team had seen at least 10 people with aphasia in the previous 3 months; Patient participants: patients with aphasia following stroke. Sex, age, proportion with ischaemic stroke and National Institutes of Health Stroke Scale not presented
Interventions	Multifaceted implementation interventions were designed to target previously identified barriers that were mapped to the behaviour change Intervention 1: Workshop (including education, persuasion, environmental restructuring, modelling) and resources to support goal setting Intervention 2: Workshop (including education, persuasion, environmental restructuring, modelling) and resources to support collaborative goal setting
Outcomes	Provision of aphasia-friendly information during hospital admission Collaborative goal-setting during hospital admission Health professionals' knowledge (about providing aphasia friendly information and collaboratively setting goals) 3 to 6 months post-intervention
Identification	(Shrubsole 2018) The Acute Aphasia IMplementation Study (AAIMS): a pilot cluster-randomised trial

Shrubsole 2018 *(Continued)*

Notes	**Country:** Australia **Setting:** Hospitals. **Declarations of interest:** none declared **First authors name:** Kirstine Shrubsole **Institution:** 4 Hospitals in QL **Email:** kirstine.shrubsole@scu.edu.au **Address:** School of Health and Rehabilitation Sciences, The University of Queensland, Brisbane, QLD, Australia **Sponsorship:** was supported by an Australian Postgraduate Award (APA) scholarship **Declarations of interest:** None declared

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	All four sites were randomised using a random interger-set generator to receive either intervention A or B
Allocation concealment (selection bias)	Low risk	All sites randomised using a random inerger-set generator
Blinding of participants and personnel (performance bias) All outcomes	High risk	Staff not blinded to group allocation
Blinding of outcome assessment (detection bias) All outcomes	Low risk	medical records were audited by an independent SLT in each cluster and blinded to group allocation
Incomplete outcome data (attrition bias) All outcomes	Low risk	Clear outcomes reported
Selective reporting (reporting bias)	Low risk	All relevant outcomes in the methods section are reported
Other bias	High risk	Low risk of selective recruitment of participants, protected against contamination. Unclear whether groups similar at baseline - Information about participating sites reported in Table 4 (state, bed numbers, speech and language therapist staffing), but comparison of baseline characteristics not analysed or presented in text. High risk of bias from comparability of baseline measures at baseline - appears to be imbalance of outcome measures at baseline presented in Table 7, but not specifically reported in text.

Wang 2018

Study characteristics

Methods	**Study design:** cluster-randomised trial

Wang 2018 *(Continued)*

	Study grouping: allocation by hospital
Participants	**Intervention scope:** hospitals with EDs and neurological wards with IV-rtPA treatment, at multiple (40) hospitals. **Health professionals:** stroke team members - physicians, nurses, therapists, discharge planning. **Patients:** 4800 (2400 in intervention group, 2400 in control group); acute ischaemic stroke; 63% male, mean age 65 years, median National Institutes of Health Stroke Scale 4. Stroke unit-only data extracted: 2979 (1680 in intervention group, 1299in control group), 25 hospitals. **Size of acute stroke unit (no. of patients admitted per year):** all intervention group hospitals: median 365, all control group hospitals: median 417. **Number of beds allocated to stroke:** all intervention group hospitals: median 70 neurological ward beds, all control group hospitals: median 80 neurological ward beds. **Urban, metropolitan or rural setting:** urban. **Public or private health insurance funding:** public hospitals
Interventions	**Intervention Characteristics** *Intervention to Bridge the Evidence-based Gap in Stroke Care Quality (GOLDEN BRIDGE—AIS) intervention* • Implementation of evidence-based clinical pathway based on peer-reviewed literature, consensus statements and guidelines, on acute stroke management, daily care plan and discharge • Implementation of written care protocols to establish performance measures • Full-time physician or nurse quality coordinator for working with physicians and training healthcare staff • Monitoring and feedback system for performance measures, checked weekly by the local investigator or quality coordinator • Two day workshop for the local investigator (director of neurology) and quality coordinator (physician or nurse) **Control** • Usual care • Stroke registry participation Aim of intervention: • Increase healthcare clinicians' adherence to evidence-based performance measures in patients with acute stroke
Outcomes	Data collected through chart audit by a blinded research coordinator not involved in patient care: **Primary outcomes** • Composite score of adherence to bundle of 9 quality of care indicators during hospital admission (IV recombinant-tPA administration within 3 hours of symptom onset, antithrombotics within 48 hours of admission, dysphagia screening, deep vein thrombosis prophylaxis, antithrombotics prescribed at hospital discharge, anticoagulants for atrial fibrillation prescribed at hospital discharge, statins for high blood cholesterol prescribed at hospital discharge, antihypertensives prescribed at hospital discharge, hypoglycaemic medication for diabetes prescribed at hospital discharge). Measured as total number of eligible performance measures performed divided by the total number of performance measures for which a given patient was eligible. • Adherence to bundle of 9 quality of care indicators during hospital admission - all or nothing score (proportion of patients who received all of the performance measures for which the patient was eligible). **Secondary outcomes**

Wang 2018 *(Continued)*

- In-hospital death
- New clinical vascular event at 3, 6, and 12 months after initial symptom onset (ischaemic stroke, hemorrhagic stroke, myocardial infarction, or vascular death)
- Disability as measured by modified Rankin Scale at 3 months, 6 months, and 12 months after initial symptom onset (mRS; score of 3 to 5);
- All-cause mortality at 3 months, 6 months, and 12 months after initial symptom onset

Identification	**Sponsorship source:** This study was supported by grants from the Ministry of Science and Technology and the Ministry of Health of the People's Republic of China (NationalS&TMajor Project of China: 2011BAI08B02, 2012ZX09303, 2013BAI09B14, 2013BAI09B03, 2015BAI12B02, 2015BAI12B04, 2016YFC0901000, 2016YFC0901002, 2017YFC1307900, 2017YFC1307905, 2017YFC1310900, 2017YFC1310901, and 2017YFC1310903); Beijing Municipal Committee of Science and Technology (D15110700200000, D151100002015001, D151100002015002, Z161100000516223, and Z141107002514125); Beijing Institute for Brain Disorders (BIBD-PXM2013_014226_07_000084); Beijing Key Laboratory for Cerebrovascular Disease (BZ0101); University of Hong Kong Stanley Ho Alumni Challenge Fund; University of Hong Kong Research Committee Seed Funding Award (104004215); and Sanofi. **Country:** China. **Setting:** 40 Chinese Stroke Center Alliance hospitals in east, central and western China. **Declarations of interest:** None declared **Authors name:** Yongjun Wang **Institution:** Beijing Tiantan Hospital **Email:** yongjunwang1962@gmail.com **Address:** Department of Neurology, Beijing Tiantan Hospital, Capital Medical University, 6 Tiantanxili, Dongcheng District, Beijing, China 100050
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"These clusters were randomized 1:1 to a multifaceted quality improvement intervention (intervention group) or routine care plus stroke registry participation (control group) by using a randomly generated number (SAS [SAS Institute], version 9.3 software). Given the nature of the multifaceted intervention, only the independent outcome evaluators and statisticians were blinded to the intervention."
Allocation concealment (selection bias)	Low risk	"These clusters were randomized 1:1 to a multifaceted quality improvement intervention (intervention group) or routine care plus stroke registry participation (control group) by using a randomly generated number (SAS [SAS Institute], version 9.3 software). Given the nature of the multifaceted intervention, only the independent outcome evaluators and statisticians were blinded to the intervention."
Blinding of participants and personnel (performance bias) All outcomes	High risk	"Given the nature of the multifaceted intervention, only the independent outcome evaluators and statisticians were blinded to the intervention."
Blinding of outcome assessment (detection bias)	Low risk	"Given the nature of the multifaceted intervention, only the independent outcome evaluators and statisticians were blinded to the intervention."

Wang 2018 *(Continued)*
All outcomes

Incomplete outcome data (attrition bias) All outcomes	Low risk	17% patient lost to follow up rate in all patients analysed – low patient loss rate. ITT analysis used.
Selective reporting (reporting bias)	Low risk	The research protocol registered - all planned outcomes are reported. The outcome measures based on Get with the Guidelines performance measures.
Other bias	Low risk	Low risk of selective recruitment of participants, protected against contamination, groups similar in terms of characteristics and outcome measures at baseline

ACU: acute stroke unit;:**ART:** Assessment for Rehabilitation Tool;**ED:** emergency department; **; IV:** intravenous;**IVT:** Intravenous thrombolytic therapy; **mRS:modified Rankin Scale; QoL:** quality of life**; SF36:** short form 36**; SLT:** speech and language therapist;**tPA:** itssue plasminogen activator

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Brady 2015	wrong intervention (not aimed at enhancing uptake of evidence-based recommendation)
Fousse 2020	wrong study design
Fu 2020	wrong participants (not health professionals working on stroke unit)
Haesebaert 2016	wrong setting (not acute stroke unit)
Haesebaert 2018	wrong setting (not acute stroke unit)
Joubert 2015	wrong setting (not acute stroke unit)
Lakshminarayan 2010	wrong setting (not acute stroke unit)
Machline-Carrion 2018	wrong setting (not acute stroke unit)
Middleton 2019	wrong setting (not acute stroke unit)
NCT00673491 2008	wrong setting (not acute stroke unit)
Panella 2008	wrong setting (not acute stroke unit)
Panella 2012	wrong setting (not acute stroke unit)
Swartz 2014	wrong study design
Williams 2016	wrong setting (not acute stroke unit)

Characteristics of ongoing studies *[ordered by study ID]*

Lou 2017

Study name	Improving In-hospital Stroke Service Utilisation in China (MISSION CHINA)

Lou 2017 *(Continued)*

Methods	Cluster-randomised trial
Participants	Patients with acute ischaemic stroke receiving thrombolysis within 4.5 hours
Interventions	A multifaceted intervention based on the Behaviour Change Wheel model compared to no intervention
Outcomes	Percentage of patients with ischaemic stroke with door-to-needle time ≤ 60 minutes Door-to-needle time Onset-to-needle time Modified Rankin Scale (mRS) score at discharge Symptomatic intracranial haemorrhage at 24 hours Favourable neurological outcomes (score 0-1 on mRS) at 90 days Death at discharge
Starting date	January 2017 to 19 August 2021
Contact information	Dr Min Lou, Zhejiang University, loumingxc@vip.sina.com
Notes	https://clinicaltrials.gov/ct2/show/NCT03317639 - unsure of applicability, but involves hospitals with stroke centres.

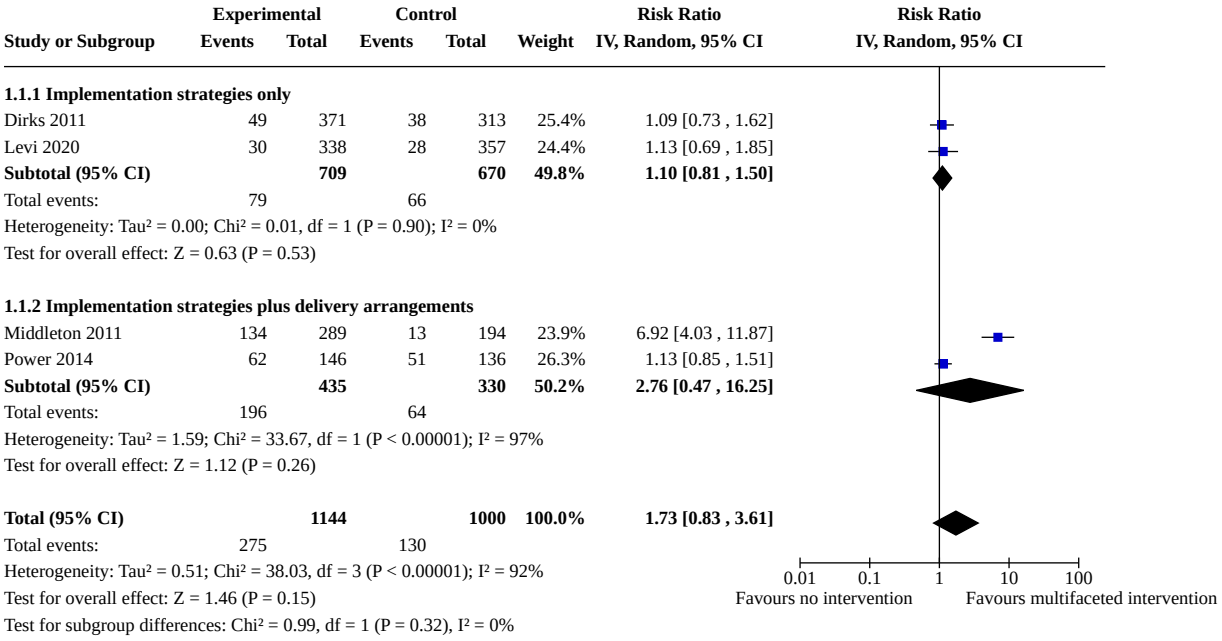
DATA AND ANALYSES

Comparison 1. Multifaceted implementation interventions versus no intervention: quality of care outcomes

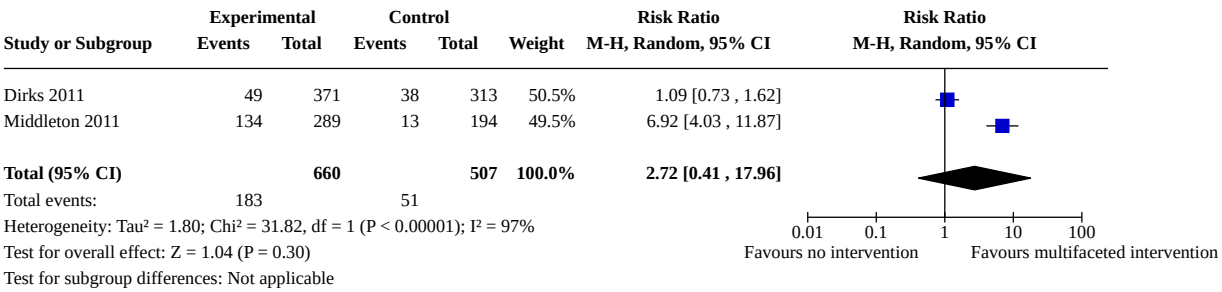
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1.1 Quality of care: Adherence with evidence-based recommendations during hospital admission	4	2144	Risk Ratio (IV, Random, 95% CI)	1.73 [0.83, 3.61]
1.1.1 Implementation strategies only	2	1379	Risk Ratio (IV, Random, 95% CI)	1.10 [0.81, 1.50]
1.1.2 Implementation strategies plus delivery arrangements	2	765	Risk Ratio (IV, Random, 95% CI)	2.76 [0.47, 16.25]
1.2 Sensitivity analysis: Quality of care: Adherence with evidence-based recommendations during hospital admission (low risk of bias)	2	1167	Risk Ratio (M-H, Random, 95% CI)	2.72 [0.41, 17.96]
1.3 Quality of care: Proportion of patients with ischaemic stroke who received thrombolysis within 24 hours of admission	2	1228	Risk Ratio (IV, Random, 95% CI)	1.14 [0.94, 1.37]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1.4 Acute medical interventions: door to needle time (minutes)	2	568	Std. Mean Difference (IV, Random, 95% CI)	0.04 [-0.13, 0.20]

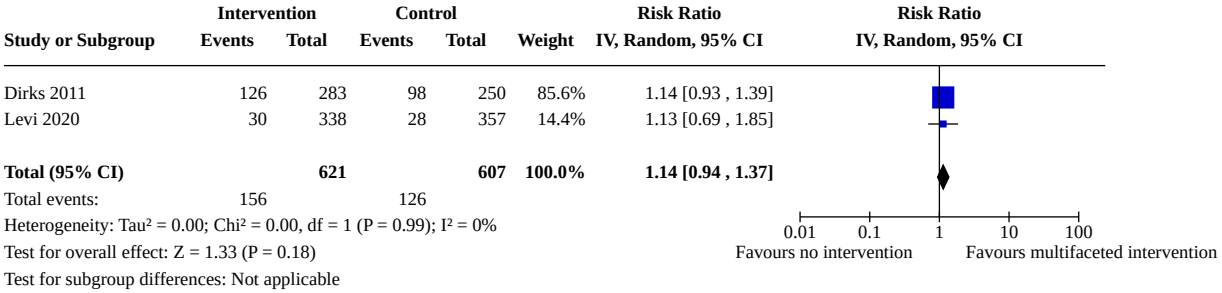
Analysis 1.1. Comparison 1: Multifaceted implementation interventions versus no intervention: quality of care outcomes, Outcome 1: Quality of care: Adherence with evidence-based recommendations during hospital admission



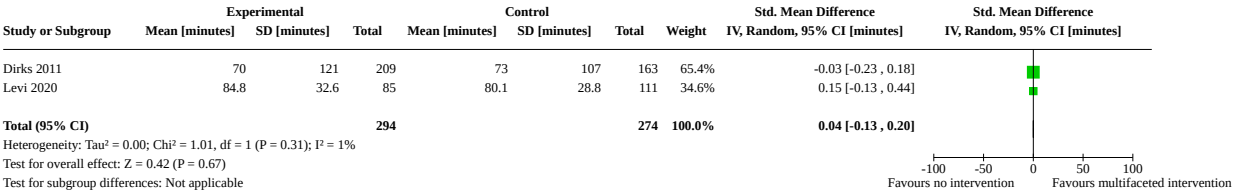
Analysis 1.2. Comparison 1: Multifaceted implementation interventions versus no intervention: quality of care outcomes, Outcome 2: Sensitivity analysis: Quality of care: Adherence with evidence-based recommendations during hospital admission (low risk of bias)



Analysis 1.3. Comparison 1: Multifaceted implementation interventions versus no intervention: quality of care outcomes, Outcome 3: Quality of care: Proportion of patients with ischaemic stroke who received thrombolysis within 24 hours of admission



Analysis 1.4. Comparison 1: Multifaceted implementation interventions versus no intervention: quality of care outcomes, Outcome 4: Acute medical interventions: door to needle time (minutes)

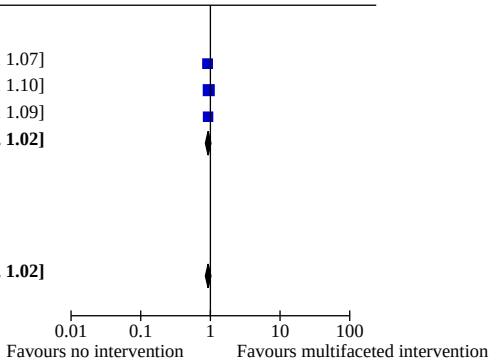


Comparison 2. Multifaceted implementation interventions versus no intervention: patient outcomes

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
2.1 Patient outcome: Risk of death, disability or dependency at 90 days	3	1228	Risk Ratio (IV, Random, 95% CI)	0.93 [0.85, 1.02]
2.1.1 New Subgroup	3	1228	Risk Ratio (IV, Random, 95% CI)	0.93 [0.85, 1.02]
2.2 Sensitivity analysis: Risk of death, disability and dependency at 90 days (low risk of bias)	2	993	Risk Ratio (M-H, Random, 95% CI)	0.92 [0.82, 1.03]
2.2.1 Sensitivity analysis	2	993	Risk Ratio (M-H, Random, 95% CI)	0.92 [0.82, 1.03]
2.3 Mortality at 90 days	2	1197	Risk Ratio (M-H, Random, 95% CI)	0.89 [0.63, 1.25]
2.4 Mortality at 1 to 4 years	2	1744	Risk Ratio (M-H, Random, 95% CI)	0.84 [0.65, 1.08]
2.5 Disability: No symptoms or no significant disability (mRS 0-1) at 90 days	2	755	Risk Ratio (M-H, Random, 95% CI)	1.35 [1.14, 1.59]
2.6 Disability: Slight, little or no disability (mRS 0-2) at 90 days	2	761	Risk Ratio (M-H, Random, 95% CI)	1.01 [0.75, 1.36]

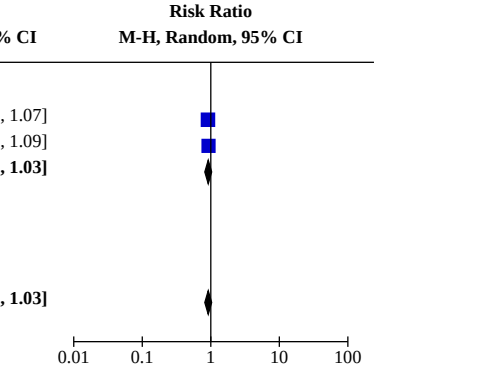
Analysis 2.1. Comparison 2: Multifaceted implementation interventions versus no intervention: patient outcomes, Outcome 1: Patient outcome: Risk of death, disability or dependency at 90 days

Study or Subgroup	Experimental Events	Experimental Total	Control Events	Control Total	Weight	Risk Ratio IV, Random, 95% CI
2.1.1 New Subgroup						
Dirks 2011	142	283	138	250	31.4%	0.91 [0.77 , 1.07]
Levi 2020	88	120	89	115	38.1%	0.95 [0.82 , 1.10]
Middleton 2011	122	228	134	232	30.5%	0.93 [0.79 , 1.09]
Subtotal (95% CI)		**631**		**597**	**100.0%**	**0.93 [0.85 , 1.02]**
Total events:	352		361			
Heterogeneity: Tau² = 0.00; Chi² = 0.14, df = 2 (P = 0.93); I² = 0%						
Test for overall effect: Z = 1.60 (P = 0.11)						
Total (95% CI)		**631**		**597**	**100.0%**	**0.93 [0.85 , 1.02]**
Total events:	352		361			
Heterogeneity: Tau² = 0.00; Chi² = 0.14, df = 2 (P = 0.93); I² = 0%						
Test for overall effect: Z = 1.60 (P = 0.11)						
Test for subgroup differences: Not applicable						



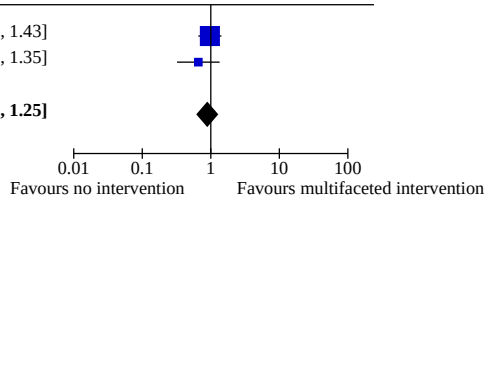
Analysis 2.2. Comparison 2: Multifaceted implementation interventions versus no intervention: patient outcomes, Outcome 2: Sensitivity analysis: Risk of death, disability and dependency at 90 days (low risk of bias)

Study or Subgroup	Experimental Events	Experimental Total	Control Events	Control Total	Weight	Risk Ratio M-H, Random, 95% CI
2.2.1 Sensitivity analysis						
Dirks 2011	142	283	138	250	50.8%	0.91 [0.77 , 1.07]
Middleton 2011	122	228	134	232	49.2%	0.93 [0.79 , 1.09]
Subtotal (95% CI)		**511**		**482**	**100.0%**	**0.92 [0.82 , 1.03]**
Total events:	264		272			
Heterogeneity: Tau² = 0.00; Chi² = 0.03, df = 1 (P = 0.87); I² = 0%						
Test for overall effect: Z = 1.47 (P = 0.14)						
Total (95% CI)		**511**		**482**	**100.0%**	**0.92 [0.82 , 1.03]**
Total events:	264		272			
Heterogeneity: Tau² = 0.00; Chi² = 0.03, df = 1 (P = 0.87); I² = 0%						
Test for overall effect: Z = 1.47 (P = 0.14)						
Test for subgroup differences: Not applicable						



Analysis 2.3. Comparison 2: Multifaceted implementation interventions versus no intervention: patient outcomes, Outcome 3: Mortality at 90 days

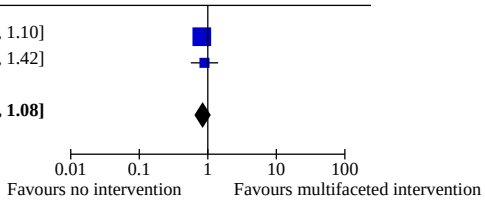
Study or Subgroup	Intervention Events	Intervention Total	Control Events	Control Total	Weight	Risk Ratio M-H, Random, 95% CI
Dirks 2011	45	283	41	250	77.3%	0.97 [0.66 , 1.43]
Middleton 2011	13	367	16	297	22.7%	0.66 [0.32 , 1.35]
Total (95% CI)		**650**		**547**	**100.0%**	**0.89 [0.63 , 1.25]**
Total events:	58		57			
Heterogeneity: Tau² = 0.00; Chi² = 0.88, df = 1 (P = 0.35); I² = 0%						
Test for overall effect: Z = 0.68 (P = 0.49)						
Test for subgroup differences: Not applicable						



Analysis 2.4. Comparison 2: Multifaceted implementation interventions versus no intervention: patient outcomes, Outcome 4: Mortality at 1 to 4 years

Study or Subgroup	Intervention Events	Intervention Total	Control Events	Control Total	Weight	Risk Ratio M-H, Random, 95% CI
Middleton 2011	67	300	65	238	70.7%	0.82 [0.61 , 1.10]
Wang 2018	37	680	32	526	29.3%	0.89 [0.57 , 1.42]
Total (95% CI)		**980**		**764**	**100.0%**	**0.84 [0.65 , 1.08]**
Total events:	104		97			

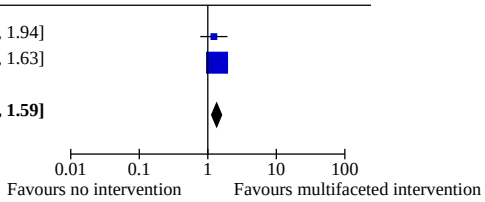
Heterogeneity: Tau² = 0.00; Chi² = 0.10, df = 1 (P = 0.75); I² = 0%
Test for overall effect: Z = 1.38 (P = 0.17)
Test for subgroup differences: Not applicable



Analysis 2.5. Comparison 2: Multifaceted implementation interventions versus no intervention: patient outcomes, Outcome 5: Disability: No symptoms or no significant disability (mRS 0-1) at 90 days

Study or Subgroup	Intervention Events	Intervention Total	Control Events	Control Total	Weight	Risk Ratio M-H, Random, 95% CI
Levi 2020	32	120	25	115	13.5%	1.23 [0.78 , 1.94]
Middleton 2011	166	288	98	232	86.5%	1.36 [1.14 , 1.63]
Total (95% CI)		**408**		**347**	**100.0%**	**1.35 [1.14 , 1.59]**
Total events:	198		123			

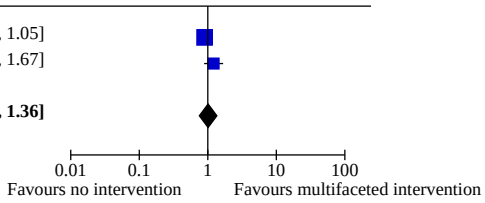
Heterogeneity: Tau² = 0.00; Chi² = 0.18, df = 1 (P = 0.67); I² = 0%
Test for overall effect: Z = 3.47 (P = 0.0005)
Test for subgroup differences: Not applicable



Analysis 2.6. Comparison 2: Multifaceted implementation interventions versus no intervention: patient outcomes, Outcome 6: Disability: Slight, little or no disability (mRS 0-2) at 90 days

Study or Subgroup	Intervention Events	Intervention Total	Control Events	Control Total	Weight	Risk Ratio M-H, Random, 95% CI
Dirks 2011	146	281	142	245	60.8%	0.90 [0.77 , 1.05]
Levi 2020	52	120	41	115	39.2%	1.22 [0.88 , 1.67]
Total (95% CI)		**401**		**360**	**100.0%**	**1.01 [0.75 , 1.36]**
Total events:	198		183			

Heterogeneity: Tau² = 0.03; Chi² = 2.87, df = 1 (P = 0.09); I² = 65%
Test for overall effect: Z = 0.07 (P = 0.95)
Test for subgroup differences: Not applicable



ADDITIONAL TABLES

Table 1. Summary of included studies

Study details			Quality indicator outcome						Other outcomes
Study and year of publication	**Design, setting, participants**	**Intervention**	**Diagnostic procedure**	**Medical intervention**	**Preventing complications**	**Goal setting and early rehabilitation**	**Planning for discharge**	**Composite 1uality Indicator**	**Patient, utilisation, resource, knowledge outcomes**
Dirks 2011	c-RCT, 12 hospitals in the Netherlands, 5515 participants with stroke	Intervention meetings based on the Breakthrough Series model		Treatment with thrombolysis within 4 h of symptom onset					Patient outcomes (death or disability at 3 months, quality of life at 3 months)
Levi 2020	c-RCT, 20 hospitals in Australia, 22,384 participants with stroke, 505 health professional (nurses and physicians) participants	Multicomponent, multidisciplinary implementation package vs control: workshop meetings, local working groups, web-based training, feedback, intersite teleconferences		Treatment with thrombolysis within 4 h of symptom onset					Patient outcomes (favourable outcomes at 3 months; symptomatic intracranial haemorrhage at 3 months) Health professional attitude at 3 months
Lynch 2016	c-RCT, 10 hospitals in Australia, 586 participants with stroke	Education only vs education, audit and feedback, barrier identification and strategy development workshop, opinion leader, reminders					Assessment for ongoing rehabilitation needs during hospital admission		
Middleton 2011	c-RCT, 19 stroke units in Australia, 1696 participants with stroke	Treatment protocols to manage fever, hyperglycaemia and swallowing dysfunction with multidisciplinary team building workshops to address implementation barriers			Swallow screen within 24 h of admission				Patient outcomes (death or dependency between 1 and 4 years; functional dependency between 1 and 4 years; quality of life; mean temperature 4 h after admission to ASU for first

Table 1. Summary of included studies *(Continued)*

							72 h; mean blood glucose on admission to hospital or admission to the ASU; aspiration pneumonia on discharge) Utilisation outcomes (length of hospital stay)
Power 2014	c-RCT, 24 hospitals in the UK, multidisciplinary team, 6592 participants with stroke	Quality improvement collaborative based on the Breakthrough Series model				Brain scan, aspirin within 24 h of admission; swallow screen within 24 h of admission	
Shrubsole 2018	c-RCT, 4 hospitals in Australia, 64 health professional (speech and language therapists) participants, 916 participants with stroke	Interactive education session and workshop, interactive PDF information package, written protocols		Collaborative goal setting during hospital stay	Information provision during hospital stay		Health professional knowledge/attitude at 3 months to 6 months
Wang 2018	c-RCT, 40 hospitals in China, 4800 participants with stroke	Evidence-based clinical pathway, written care protocols for implementation of performance measures, a full-time quality coordinator and a monitoring and feedback system. Training in quality improvement methods				Treatment with thrombolysis within 3 h of symptom onset, early antithrombotics within 48 h of admission, swallow screen during hospital admission, DVT prophylaxis during	Patient outcomes at 3 months, 6 months and 12 months (in-hospital mortality; new clinical vascular event; disability; mortality)

Table 1. Summary of included studies *(Continued)*

							hospital admission, antithrombotics on discharge, anticoagulation for atrial fibrillation on discharge, lipid-lowering medication on discharge, antihypertensive medication on discharge, antidiabetic medication on discharge

Abbreviations: ASU: acute stroke unit; c-RCT: community-randomised controlled trial; DVT: deep venous thrombosis

Table 2. The Effective Practice and Organisation of Care taxonomy of health systems interventions[a]

	Dirks 2011	Levi 2020	Lynch 2016	Middleton 2011	Power 2014	Shrubsole 2018	Wang 2018
Delivery arrangements				**Yes**	**Yes**		**Yes**
How and when care was delivered				Yes			
Where care was provided and changes to healthcare environment							
Who provided care and how healthcare workforce was managed							
Coordination of care and management of care processes				Yes	Yes		Yes
Information and communication technology							
Financial arrangements							

Table 2. The Effective Practice and Organisation of Care taxonomy of health systems interventions[a] *(Continued)*

Governance arrangements

Implementation strategies	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Interventions targeted at healthcare workers	***Yes***	***Yes***	***Yes***	***Yes***	***Yes***	***Yes***	***Yes***
Audit and feedback		Yes	Yes		Yes		Yes
Clinical incident reporting							
Monitoring the performance of the delivery of health care					Yes		Yes
Communities of practice					Yes		Yes
Continuous quality improvement	Yes				Yes		Yes
Educational games							
Educational materials	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Educational meetings		Yes			Yes	Yes	Yes
Educational outreach visits/academic detailing		Yes	Yes	Yes	Yes	Yes	Yes
Clinical practical guidelines	Yes			Yes			Yes
Interprofessional education		Yes	Yes	Yes	Yes		Yes
Local consensus processes	Yes		Yes	Yes	Yes		Yes
Local opinion leaders		Yes	Yes	Yes	Yes		Yes
Managerial supervision							Yes
Patient-mediated interventions							
Public release of performance data							
Reminders			Yes	Yes			
Routine patient-reported outcome measures							

Table 2. The Effective Practice and Organisation of Care taxonomy of health systems interventions[a] *(Continued)*

Tailored interventions	Yes		Yes	Yes			
Interventions targeted at healthcare organisations							
Interventions targeted at specific types of practice, conditions or settings	***Yes***	**Yes**	***Yes***	***Yes***	***Yes***	***Yes***	***Yes***

[a]Description of the Cochrane Effective Practice and Organisation of Care (EPOC) taxonomy of health systems interventions can be found at https://epoc.cochrane.org/sites/epoc.cochrane.org/files/public/uploads/epoc_taxonomy_13.12.16.pdf

Table 3. Implementation intervention, comparisons and targeted evidence-based practices in included studies

Study ID	Implementation intervention	Control	Targeted evidence-based practice
Dirks 2011	Five implementation meetings based on the breakthrough series model, with teams that included a stroke neurologist and a stroke nurse	Usual care, hospitals without implementation meetings	Multidisciplinary stroke unit team to provide thrombolysis to higher proportion of participants
Levi 2020	Multicomponent, multidisciplinary tissue plasminogen activator implementation package Has 7 components • Preworkshop meetings • Collaborative communal workshops • Site-based working groups • Web-based training modules • Regular telephone case monitoring • Bimonthly feedback of IVT rate • Bimonthly intersite teleconferences	Usual care, hospitals without multicomponent intervention	Multidisciplinary stroke unit team to provide thrombolysis to higher proportion of participants
Lynch 2016	Multifaceted intervention consisting of • Onsite education sessions • Distribution of the assessment for rehabilitation tool • Opinion leaders and reminders to increase the effectiveness of intervention • Audit and feedback • Barrier identification and strategy development session • Interdisciplinary teamwork and development of time-efficient systems and procedures	Education intervention consisting of • Onsite education session • Distribution of the assessment for rehabilitation tool	Multidisciplinary stroke unit team to improve proportion of participants who receive stroke rehabilitation need assessment for people with stroke
Middleton 2011	Evidence-based treatment protocol • Barrier identification • Reinforcement of multidisciplinary teamwork • Local adaptation • Use of site champions • Panels of experts developed clinical treatment protocol • Team building workshop • Site-based interactive and didactic outreach sessions • Site visits and telephone and email support as reminders	Usual care. Received an abridged version of existing guidelines	Multidisciplinary stroke unit team to improve guideline-based management of fever, hyperglycaemia and swallowing dysfunction for stroke participants
Power 2014	Multifaceted approach to quality improvement Involves 5 essential features • An agreed topic and aim • Clinical and quality improvement experts who provide support for improvement by acting as faculty • Multiprofessional teams from multiple sites who participated in the IQC • Use of an agreed model for improvement	Usual care, hospitals without multifaceted approach to quality improvement	Multidisciplinary stroke unit team working collaboratively to provide quality acute stroke care for stroke participants

Table 3. Implementation intervention, comparisons and targeted evidence-based practices in included studies *(Continued)*

	• Series of structured activities including face-to-face meetings		
Shrubsole 2018	Multifaceted intervention Received 1 of 2 interventions: • Information provision: a single, face-to-face 2.5-hour interactive education session and workshop to improve information provision • Goal setting: a single, face-to-face, 2.5-hour interactive education session and workshop to improve collaborative goal setting	Alternate intervention (information or goal setting)	Multidisciplinary stroke unit team to increase information provision or collaborative goal setting for higher proportion of stroke participants
Wang 2018	Multifaceted quality improvement intervention • Clinical pathway • Care protocols • Quality coordinator oversight • Performance measures monitoring and feedback	Usual care	Multidisciplinary stroke unit team to improve provision of evidence-based treatment for higher proportion of stroke participants

Abbreviations: IQC: internal quality control; IVT: intravenous thrombolysis

Table 4. StaRI checklist – Dirks 2011[a]

	Page	Implementation strategy How the intervention was implemented	Page	Intervention What was the healthcare intervention being implemented
StaRI criteria number				
Title and abstract				
1. Title	1	"Promoting Thrombolysis in Acute Ischemic Stroke" identifies promoting thrombolysis as an implementation study.		
2. Abstract	1	Identification as an implementation study: The PRomoting ACute Thrombolysis in Ischemic StrokE (PRACTISE) trial evaluated the effectiveness of a multidimensional implementation strategy for thrombolysis with intravenous recombinant tissue plasminogen activator in acute ischemic stroke. Implementation strategy tested: The intervention included 5 implementation meetings based on the Breakthrough Series model. The evidence-based intervention being implemented was not reported. The primary outcome was treatment with thrombolysis. Secondary outcomes were admission within 4 hours after onset of symptoms, death or disability at 3 months, and quality of life.		
Introduction				
3. Introduction	1	There is undertreatment of thrombolysis for participants with AIS, due to barriers to applying thrombolysis. Barriers can be interorganisational, intraorganisational, medical and psychological.		
4. Rationale	1	Identify barriers to applying thrombolysis in order to develop targeted interventions	1	Address barriers to improve clinical care, including:

Table 4. StaRI checklist – Dirks 2011[a] *(Continued)*

		• arrival of participants to hospital for Tx • availability of lab staff, CT scans, skilled nurses • identifying patient eligibility for thrombolysis • risk aversion of physicians		
5. Aims and objectives	1	In this study, authors investigated whether the proportion of patients treated with thrombolysis [intervention objective] in hospitals can be increased in real-life settings through a multifaceted implementation strategy aimed at resolving potential treatment barriers [implementation objective].		
Methods (description)				
6. Design and key features	1	National cluster RCT, with protocol published as a separate paper		
7. Context of intervention	1, 2 of protocol	While up to 25% of people with AIS may be eligible for thrombolysis, international thrombolysis Tx rates are low. Similarly, in the Netherlands Stroke Survey, only 7% of all acute stroke patients were treated with thrombolysis. The authors aimed to increase thrombolysis for people with AIS, given the current low Tx rate.		
8. Characteristics of target groups	2	Sites with readiness to deliver AIS care, including presence and content of protocols, level of formal education and infrastructure around and within the hospital (for instance, the number of ambulance services, specialists and residents)	2	All patients 18 years with acute stroke who were admitted to the hospital within 24 hours from onset of symptoms were included in the trial. Patients admitted within 4 hours were assessed in detail and were followed up to 3 months after onset by telephone.
9. Description of implementation strategy/intervention	2	The implementation strategy for thrombolysis consisted of intervention meetings based on the Breakthrough Series model. Local teams were formed that included a stroke neurologist and a stroke nurse. Teams were asked to note specific local barriers to further implementation in their hospital, to set goals, and to plan actions to reach these goals in a reasonable timeframe, and the researchers monitored the results of their actions. Each team was asked to evaluate and update their acute stroke guideline. The intervention continued for 2 years and comprised 5 half-day intervention meetings and 1 closing session. The meetings started in May 2005, almost 6 months before the start of data collection.	2	Tx with rtPA for AIS
10. Subgroups or nested studies	2	Subgroup: people with AIS admitted within 4 h of onset		

Table 4. StaRI checklist – Dirks 2011[a] *(Continued)*

Methods (evaluation)

11. Prespecified outcomes	53 of 2012 thesis, 2	Hospital organisation culture was not targeted as an outcome of the implementation strategy but was scored to investigate link between hospital work culture and tPA rates. Hospital culture was scored by presence and content of protocols, the level of formal education, and the infrastructure around and within the hospital (for instance, the number of ambulance services, specialists, and residents).	2	The primary outcome was treatment with rtPA in the total stroke population and in the subgroup of patients with an ischemic stroke admitted within 4 hours. Secondary outcomes were admission within 4 hours after onset of symptoms, death or disability at 3 months measured with the modified Rankin Scale (mRS), and quality of life measured with the EuroQoL. Tertiary outcomes were onset-to-door time and door-to-needle time as process indicators of the timelines of acute stroke car"
12. Process evaluation objectives and outcomes	52-4 of 2012 thesis	Evaluation of the success of the implementation strategy indicated by changes in the intervention outcomes (i.e. thrombolysis rate, patient outcomes, onset-to-door time and door-to-needle time). Organisational scores of participating hospitals were scored, but this was not analysed based on IG vs CG allocation.		
13. Economic and resource cost	67 of 2012 thesis	The implementation costs included the costs of the implementation i.e. the staff time spent, as recorded in the time logbook in the two treatment arms, as well as the overall cost of the Breakthrough Series implementation program in the intervention group (PRACTISE data).	67 of 2012 thesis	The treatment cost of alteplase accounted for the dosage of alteplase, the cost of additional nursing time (1 hour) and physician time (15 minutes) to prepare and administer the drug, and the time for the consultant neurologist for treatment assessment outside office hours (15 minutes). Hospital admission cost accounted for the days at the stroke unit, the additional costs for academic hospitals, and the Computer Tomography scans (PRACTISE data)(Table 2b). Follow-up costs were estimated using the EDISSE data and were determined by patients' disability scores. Patients in the mRS 0-1 category were discharged home with no extra costs. Patients in the mRS 2-3 category were discharged home with additional home care and remedial therapy costs (based on edisse data). Patients in the mRS 4 category were discharged (depending on age) to a rehabilitation centre (if younger than 65 years) or a nursing home (if aged 65 years or older). Patients in the mRS 5 category were discharged to a

Table 4. StaRI checklist – Dirks 2011[a] *(Continued)*

		nursing home. The cost index year is 2010.		
14. Sample size rationale	2	With adjustments for randomization at the center level, the expected size of the study (12 hospitals, 5000 registered patients) was considered to be sufficient to detect a statistically significant (a=0.05) increase in thrombolysis rate in the intervention hospitals with a power of 80%. This calculation was based on the assumption of a relative increase of 50% in thrombolysis rate in the intervention hospitals superimposed on an secular, increasing trend, leading to an estimated thrombolysis rate of 7.5% in the control hospitals and 11.3% in intervention hospitals.		
15. Methods of analysis		Intervention analysis: Statistical analysis was carried out on an intention-to-treat basis. In the analysis of the primary and secondary outcome, authors used a multilevel logistic regression model to adjust for potential clustering effects. In the analysis of the tertiary outcome, authors used a multilevel linear regression model. In addition, adjustments were made for hospital size, type of hospital, and previous thrombolysis rates at the hospital level. At the individual patient level, adjustments were made for age and sex. Intervention effects were reported as ORs with 95% CI. STATA Version 10 was used to analyse the data (STATA Corp, College Station, TX). Cost-effectiveness analysis: Multiple simulation rounds were made of 10,000 iterations to ascertain the robustness of the average individual outcome estimates on lifetime health (QALYs) and lifetime costs (2010 US$) in both arms. Incremental costs and health effects were plotted in a cost-effectiveness plane, including confidence ranges (5%, 50%, and 90%) around a central point-estimate.		
16. A prior subgroup analysis or nested research tasks		In the group of patients admitted within 4 hours, adjustments were made for stroke severity and comorbidity. Intervention effects were reported as ORs with 95% CI. STATA Version 10 was used to analyze the data (STATA Corp, College Station, TX).		
Results				
17. Characteristics of participants recruited	2	Local teams that included a stroke neurologist and a stroke nurse…Local neurologists and paramedical personnel in intervention hospitals were aware that they participated in a program to enhance the rate of thrombolysis.	3	5515 stroke participants registered – with 1657 in the subgroup (AIS participants admitted in < 4 h) → of these, 701 treated were with rtPA
18. Outcomes	3, Table 1	Hospital culture score for protocols, education and infrastructure reported in Table 1, to describe hospital setting Outcomes of the implementation strategy (i.e. the effect of the Breakthrough Series on stroke teams) were not reported.	4, Table 3	Primary, secondary and tertiary outcomes in Table 3
19. Process data	4	2990 intervention and 2525 control group AIS participants registered for study Thrombolysis rate: 393 and 308 Onset-to-door time: 424 and 392 min		
20. Resource use, costs, economic outcomes	68 of 2012 thesis	Resource use per patient, by IG and CG Total implementation costs: 144 vs 70 USD	68-9 of 2012 thesis	Resource use per patient, by IG and CG Thrombolysis cost (Tx with alteplase): 478 vs 427 USD No. of CT scans: 1.4 vs 1.6 Cost of CT scans: 252 vs 280 USD

Table 4. StaRI checklist – Dirks 2011[a] *(Continued)*

				Length of hospital stay: 9.7 vs 9.9 days Cost of hospital admission: 4555 vs 4759 USD Cost of long-term care: 3763 vs 4112 USD Cost of patient care at 3 months: 9192 vs 9647 USD Lifetime cost of patient care: 22,994 vs 24,315 USD QALY cost for lifetime: 3.89 vs 3.84 years
21. Representativeness and outcomes of subgroups	4	Subgroup analysed: 880 intervention and 777 control group AIS participants admitted in < 4 h Thrombolysis rate: 391 and 305 mRS < 3 (improved health outcomes) at 3 months: 441 and 429 Mortality at 3 months: 141 and 127 Onset-to-door time: 91 and 90 min Door-to-needle time: 70 and 73 min NIHSS at discharge: 4 and 5		
22. Fidelity to implementation or intervention		Not reported		Not reported
23. Contextual changes affecting outcomes		Not reported		
24. Harms or unintended effects	1 of Suppl file	In intervention and control hospitals: Symptomatic ICH bleed rate: 5.6% and 4.6% Anaphylactic reaction: 1% and 1.7% Other bleeding complications: 1% and 1%		
25. Summary of findings, strengths, limitations, comparisons to other studies	5	Findings: The proportion of patients treated with rtPA increased through an intensive implementation strategy in real-life settings. Among the patients admitted within 4 hours after onset, the likelihood of treatment with rtPA was higher in the intervention centres also after adjustment for prespecified center and patient characteristics. The rate of symptomatic intracranial bleeding complications was nonsignificantly higher in the intervention group and an important increase in bleeding rate is not ruled out. However, the complication rate was similar to the rate in clinical trials and registries, indicating that the implementation actions did not lead to increased adverse health effects. Strengths: extent of blinding and lack of contamination risk (control group largely blinded; all participants blinded; outcome assessors blinded); participating hospitals are representative of urban/regional/large academic hospitals in the Netherlands Limitations: 12 hospitals participating = only 11% of hospitals in the Netherlands PRACTISE was compared to one study where clinical education by local leaders improved Tx of AMI following guideline implementation.		
26. Discussion of policy, practice or research implications	5, 6	No single component or combination of components in the structure of the stroke service could explain the intervention effect. However, authors observed that in the intervention hospitals, more patients were treated with alteplase with a	5	The proportion of patients treated with rtPA increased through an intensive implementation strategy in real-life settings. There should not be a change – tPA is still the gold standard Tx of AIS.

Table 4. StaRI checklist – Dirks 2011[a] *(Continued)*

		lower NIHSS score and there were less ambiguous contraindications. In the hospital that stopped participating in the intervention strategy, authors observed an initial increase in thrombolysis rate during active participation in the study and a decrease in thrombolysis rate after the hospital dropped out. This suggests that implementation needs to be a continuous process of measuring, adaptation, and feedback. In addition, the time period between the breakthrough sessions may have been too long, which may have led to lower compliance and loss of motivation.		
27. Regulatory approval, trial/study registration, funding, conflicts of interest	1, 6	The medical ethics committees in each participating centre assessed the study protocol. Protocol: ISRCTN 20405426 Funding: This study was funded by the Netherlands Organisation for Health Research and Development (ZON-MW, grant number 945-14-217). ZON-MW is the national health council appointed by the Ministry of Health (VWS) and the Netherlands Organisation for Scientific Research (NWO) to promote quality and innovation in the field of health research and care. No conflict of interest		

[a]Description of the StaRI checklist can found at https://www.bmj.com/content/356/bmj.i6795
Abbreviations: AIS: acute ischaemic stroke; CG: control group; CI: confidence interval; CT: computed tomography; EuroQoL: European Quality of Life Scale; ICH: intracerebral haemorrhage; IG: intervention group; mRS: modified Rankin Scale; NIHSS: National Institutes of Health Stroke Scale; OR: odds ratio; PRACTISE: Promoting Acute Thrombolysis for Ischaemic Stroke; QALY: quality-adjusted life year; RCT: randomised controlled trial; rtPA: recombinant tissue plasminogen activator; StaRI: Standards for Reporting Implementation Studies; tPA: tissue plasminogen activator; Tx: treatment

Table 5. StaRI checklist – Levi 2020

	Page	Implementation strategy How the intervention was implemented	Page	Intervention What was the healthcare intervention being implemented
Title and abstract				
1. Title	1	The study is identified as an implementation study with thrombolysis implementation support and keywords health system change, implementation and quality improvement. The method of the study is a cluster-randomized trial.		
2. Abstract	1	The study is a multicomponent, multidisciplinary tissue plasminogen activator implementation package for increasing the proportion of thrombolyzed cases. The implementation strategy is based on behavioral theory and analysis of the steps, roles, and barriers to rapid assessment for thrombolysis eligibility and involved comprehensive strategies addressing individual and system-level change. The evidence-based intervention being implemented is the use of tissue plasminogen activator for acute ischaemic stroke.		

Table 5. StaRI checklist – Levi 2020 *(Continued)*

		The key outcome is increasing intravenous thrombolytic therapy rates while maintaining accepted benchmarks for low rates of intracranial hemorrhage and high rates of functional outcomes at 3 months.		
Introduction				
3. Introduction	1	Effective treatment for acute ischemic stroke remains limited to strategies promoting early reperfusion of the ischemic brain. Intravenous thrombolysis (IVT) using tPA is the only approved drug therapy and the only widely available treatment option. However, tPA is underutilized in most healthcare systems.		
4. Rationale	2	Factors recognized to enhance IVT implementation include expert and coordinated multidisciplinary care, individual and team-based advanced knowledge and skills, streamlined systems of care, and clinician experience, confidence, and acceptance of risk.	1-2	Intravenous thrombolysis (IVT) using tissue plasminogen activator (tPA) is the only approved drug therapy and the only widely available treatment option. However, tPA is underutilized in most healthcare systems. One likely reason for undertreatment is that IVT is a complex intervention.
5. Aims and objectives	2	The TIPS trial aimed to address IVT undertreatment in the Australian healthcare system by testing whether a multicomponent, multidisciplinary collaborative intervention could: 1. Increase the proportion of all stroke participants receiving thrombolysis at intervention hospitals, compared with control hospitals. 2. Maintain best-practice benchmarks for stroke outcomes. 3. Ensure that the adverse event rate for symptomatic intracranial hemorrhage did not rise above best-practice benchmarks.		
Methods (description)				
6. Design and key features	2, 4	A cluster-randomized trial conducted in 20 hospitals across 3 states of Australia (New South Wales, Victoria, and Queensland) between 2011 and 2015 that evaluated the effectiveness of a multicomponent, multidisciplinary collaborative intervention to improve implementation of IVT. A protocol paper was published in 2014, available at https://doi.org/10.1186/1748-5908-9-38. The evaluation will identify the proportion of stroke cases in each hospital that were treated with tPA within each month, defined as the number of cases entered in the hospital tPA data set divided by the total number of stroke cases. Process evaluation measures consist of intervention involvement at each intervention site and change in staff attitudes.		
7. Context of intervention	2, 2014 protocol	In Australia, IVT implementation had plateaued over the previous decade, and the TIPS (Thrombolysis Implementation in Stroke) trial ran at a time when the national average of ischemic strokes patients receiving IVT was 7%, giving emphasis to the magnitude of Australia's undertreatment problem.		
8. Characteristics of target groups	2, 2014 protocol	Eligible hospitals are those with a Stroke Care Unit or staffing equivalent of a stroke physician and stroke nurse; an Emergency Department and where the hospital is at early	2014 protocol	Information on each patient thrombolysed during the study period was entered into the secure TIPS database hosted on the Nation-

Table 5. StaRI checklist – Levi 2020 *(Continued)*

		stages of thrombolysis implementation. Early-stage implementation [defined as] (<10% thrombolysis implementation rate or had commenced intravenous thrombolysis delivery within 5 years previously), or about to commence IVT implementation. All participating hospitals are required to record every consecutive case of stroke and thrombolysis, including adverse events and patient functional outcomes at three months. Further, all sites agreed to participate in ongoing continuous audit of IVT processes of care and outcomes. Public and private hospitals and teaching and nonteaching hospitals were eligible for inclusion. Participating hospitals were identified from National Stroke Foundation audit records and in communication with New South Wales, Victoria and Queensland Stroke Unit Networks.		al Stroke Foundation (NSF) website.
9. Description of implementation strategy/intervention	3-4, 2014 protocol	Implementation strategies outlined in the 2014 protocol involved: 1. Situational analysis – clarifying the patient journey including prehospital assessment, triage, clinical assessment, imaging, final clinical assessment, preparation and delivery of thrombolysis. 2. Change agents (i.e. stroke nurse champions to monitor and encourage completion of the nurse professional development training) 3. Information-based target setting involving a process of setting overall targets for appropriate and achievable rates of thrombolysis for each site. 4. Collaborative problem solving occurred within site working groups during their bi-weekly meetings and bimonthly teleconferences between the primary change agent. 5. Professional development, where detailed education and training regarding clinical decision making for thrombolysis [was] provided via webbased educational modules.	3	Intervention components were developed in accordance with a behavior-change wheel method and strategies. The behavior-change wheel emphasizes the importance of ensuring that staff involved in change have the capability, opportunity, and motivation to perform the desired behavior; behavior-change techniques include education, training, environmental restructuring, modeling, and enablement.

Table 5. StaRI checklist – Levi 2020 *(Continued)*

		6. Performance feedback, where local and comparative feedback was provided for three monthly estimated proportion of ischaemic stroke cases who receive thrombolysis, graphed against site targets and comparative data showing each site how it compares to other intervention hospitals to create a positive level of competition among peers. Seven intervention components were delivered over 16 months via a suite of activities. Briefly, these activities included preworkshop meetings, collaborative communal workshops, site-based working groups, web-based training modules, regular telephone case monitoring, bimonthly feedback of IVT rate, and bimonthly intersite teleconferences.		
10. Subgroups or nested studies	3	Although 3 strata based on baseline IVT rates were identified, no subgroup analysis was conducted. These strata were very low rates (0% to ≤4.0%); low rates (>4.0% to ≤10.0%); and moderate rates (>10.0%) of IVT.		
Methods (evaluation)				
11. Prespecified outcomes	4	Process measures included intervention involvement at each intervention site and change in staff attitudes. Intervention involvement was assessed by the health behavior change expert of the research team against each intervention component using a scoring rubric of [0-2, low, medium and high level engagement], according to the proportion of eligible staff participating in intervention components included as assessment of executive support for IVT; attendance at meetings, workshops, and teleconferences; and uptake of online training modules. Staff attitudes were assessed using a cross-sectional pen-and-paper survey, which was distributed to medical and nursing staff at all 20 study sites who were involved in assessment of potential stroke cases and stroke care during both the baseline phase and follow-up phase of the trial. These data will be reported separately.	4	The primary outcome measure was the proportion of stroke cases in each hospital that were treated with tPA within each month, defined as the number of cases entered in the hospital tPA data set divided by the total number of stroke cases. Secondary outcomes were the proportion of patients treated with IVT experiencing (1) favorable 3-month outcomes (mRS score 0-1) and (2) symptomatic intracranial hemorrhage.
12. Process evaluation objectives and outcomes	4	Process measures included intervention involvement at each intervention site and change in staff attitudes. Intervention involvement was assessed by the health behavior change expert of the research team against each intervention component using a scoring rubric of [0-2, low, medium and high level engagement], according to the proportion of eligible staff participating in intervention components included as assessment of executive support for		

Table 5. StaRI checklist – Levi 2020 *(Continued)*

		IVT; attendance at meetings, workshops, and teleconferences; and uptake of online training modules. Staff attitudes were assessed using a cross-sectional pen-and-paper survey, which was distributed to medical and nursing staff at all 20 study sites who were involved in assessment of potential stroke cases and stroke care during both the baseline phase and follow-up phase of the trial.		
13. Economic and resource cost		No methods for resource use, costs, economic outcomes and analysis were undertaken.		
14. Sample size rationale	4	From the baseline data, it was estimated that participating hospitals (not all equal in size) would have an average of 150 stroke patients per year, that 5% of stroke patients in the control group would receive tPA, and that the average coefficient of variation across strata would be 0.4. With 10 hospitals per treatment group, and data collected for 12 months postintervention, the study would have 80% power with a 5% significance level to detect an absolute difference of 7% to 10% in the IVT rate.		
15. Methods of analysis	5	Thrombolysis rates were modelled in a number of ways. In the primary, prespecified analysis, the absolute difference between the intervention and control group thrombolysis rates during the postintervention phase was compared using a linear regression model adjusted for baseline thrombolysis rate and strata. As a secondary, posthoc analysis,thrombolysis rates were modeled at each time point relative to the thrombolysis rate for the full baseline period. A generalized linear mixed-effect model was used under a binomial distributional assumption with a log-link function, a site-level random intercept, and fixed effects for time points, intervention groups, and their interaction. Parameter estimates from this model, when exponentiated, reflect the relative increase/decrease in the change from baseline thrombolysis rates for intervention and control sites and the difference between them. Analyses of the primary outcome were intention-to-treat in that the numerator included all individuals administered tPA, and the denominator was obtained from hospital separations data.		
16. A prior subgroup analysis or nested research tasks		No subgroup analysis was conducted.		
Results				
17. Characteristics of participants recruited	5	20 hospitals agreed to participate; 4 in Victoria, 3 in Queensland, and 13 in New South Wales. The hospitals ranged from 65 to 716 stroke cases per year at baseline. The majority of hospitals serviced regional cities and adjacent rural populations with a catchment radius of up to 300 km and an average population base of 40 000 people. There were 6 outer metropolitan hospitals situated in each of the state capitals serving urban and regional communities of over 100 000; 2 metropolitan academic private hospitals, and 2 metropolitan academic public hospitals. For the duration of the trial there was limited access to endovascular reperfusion therapies in the metro-	5, Table 2 on page 7	The characteristics of the patients treated with IVT across the 2 groups at baseline are shown in Table 2.

Table 5. StaRI checklist – Levi 2020 *(Continued)*

		politan centres and no access from regional centres.		
18. Outcomes	5	The level of involvement with each intervention component at each intervention site is described in Table 3. There was a varying level of involvement with each intervention component, with site scores ranging from 11 up to 20 out of a maximum possible score of 22. Comparison of staff attitudes at baseline versus follow-up found a significant positive change in attitude score for physicians (change in group mean score=1.4, 95% CI 0.3-2.6; P<0.05) but not for nurses (P>0.5).	5-6	285 of 5331 stroke patients were treated with IVT in the intervention hospitals (5.3%, 95% CI 4.7% to 5.9%) compared with 314 of 5583 patients (5.6%, 95% CI 5.0% to 6.2%) in control hospitals. During the intervention study period, IVT rates increased in the intervention hospitals to an average of 8.9% (281 of 3160 strokes; 95% CI 7.9% to 9.9%). However, rates also increased over this time period in the control hospitals to an average of 8.2% (257 of 3116 strokes; 95% CI 7.3% to 9.2%) although the intervention hospitals maintained IVT rates over the postintervention period at an average of 8.7% (221 of 2527 strokes; 95% CI 7.6% to 9.8%), the IVT rates in the control hospitals declined to 7.9% (210 of 2667 strokes; 95% CI 6.9% to 8.9%).
19. Process data	5	The level of involvement with each intervention component at each intervention site is described in Table 3. There was a varying level of involvement with each intervention component, with site scores ranging from 11 up to 20 out of a maximum possible score of 22. Comparison of staff attitudes at baseline versus follow-up found a significant positive change in attitude score for physicians (change in group mean score=1.4, 95% CI 0.3-2.6; P<0.05) but not for nurses (P>0.5).		
20. Resource use, costs, economic outcomes		No methods for resource use, costs, economic outcomes and analysis were undertaken.		
21. Representativeness and outcomes of subgroups		No subgroup analysis was conducted.		
22. Fidelity to implementation or intervention	5	The level of involvement with each intervention component at each intervention site is described in Table 3. There was a varying level of involvement with each intervention component, with site scores ranging from 11 up to 20 out of a maximum possible score of 22.		While not directly reported, the primary outcome of IVT rates appears to indicate the fidelity toward the intervention.

Table 5. StaRI checklist – Levi 2020 *(Continued)*

23. Contextual changes affecting outcomes	9-11	Some contextual information about the intervention is included in the Discussion: "In Australia especially, here has been some heated, longstanding, and factional disagreement between neurologists and emergency physicians about the effectiveness of thrombolysis... some centers had to overcome hostile colleagues to facilitate IVT implementation. Such barriers can substantially hinder system change. Local champions, such as the stroke unit leaders who were present at every participating center in this trial, are not necessarily sufficient on their own to overcome such large barriers, particularly when an intervention such as IVT requires collaboration between emergency department teams and stroke teams. It is clear that some centers rose to the challenge of system change, although others were unable to achieve much progress. It will be instructive to look at the characteristics of these centers (including leadership styles or skills and team climate) where the intervention fell on fertile soil compared with those where it fell on more rocky terrain. Aspects that were out of scope for TIPS but are recognized to have potential impact on IVT implementation are the streamlining of prehospital systems of care and telemedicine support for tPA delivery in smaller regional centers that lack stroke expert workforce and are limited by the long travel times between patient residences and the hospitals. Acute stroke telemedicine in the emergency departments of regional hospitals was implemented in Victoria before commencement of TIPS, 27 and a hospital bypass and prenotification system was rolled out across New South Wales in 2012-2013. Confining larger-scale prehospital systems reforms or telestroke models of care to intervention hospitals alone was not a feasible option and therefore was not included in the intervention package."
24. Harms or unintended effects	6	Secondary outcomes were the proportion of participants treated with IVT experiencing (1) favourable 3-month outcomes (mRS score 0 to 1) and (2) symptomatic intracranial haemorrhage. After adjustment for multiple comparisons, 1 control site did show a significantly lower rate of favorable outcome, as judged by mRS of 0 to 1, compared with the benchmark of 30%; some centers were performing significantly better (Table S2). Two intervention sites showed significantly better rates of intracranial hemorrhage postintervention, and no centers performed significantly worse on proportion of people with intracranial hemorrhage, compared with the benchmark of 6%; some centers were performing significantly better."
Discussion		
25. Summary of findings, strengths, limitations, comparisons to other studies	6-9, 11	Summary of findings, strengths and limitations, comparisons with other studies, conclusions and implications The TIPS multicomponent collaborative intervention resulted in a small but temporary improvement in IVT implementation rates across the 10 intervention hospitals. This rise was evident toward the end of the 16-month intervention support period and dissipated over the 12 months following withdrawal of external support. Comparison is made to the INSTINCT trial with an IVT support implementation intervention; the PRACTISE trial, which used breakthrough methodology involving formation of local teams, identification of barriers, and setting of action plans and improvement goals along with a series of intervention site meetings; a French implementation trial that tested a systems intervention in a randomized stepped-wedge controlled design; and the T3 Trial, which featured multidisciplinary workshops to assess barriers and identify strategies, educational material delivered face to face, online, and in written form, support from local and national clinical experts, and proactive site visits and teleconferences. Limitations discussed include increased workload pressure for stroke team physician leaders, that time required for the intervention hospital nurses to complete training and the limited existing stroke expert nursing capability in regional centers may have further compromised the formation of functional quality improvement teams and lack of dedicated time to participate in research, with few medical staff completing the TIPS modules. The strengths of this study included an evidence-based implementation science research design based on the behaviour change wheel.

Table 5. StaRI checklist – Levi 2020 *(Continued)*

		Study implications: A longer intervention period (as suggested by the secondary analyses) and greater intensity of the TIPS intervention activities may be required, such as additional workshops and more peer-to-peer interaction, necessitating redesign of the intervention in an effort to achieve greater and more sustainable change and the development of higher-level policy for improvement in stroke thrombolysis implementation, addressing issues such as expert workforce capacity building, healthcare management accountability to benchmarks, and incentives for achieving benchmark performance in IVT.
26. Discussion of policy, practice or research implications	11	For sustainability, the trial will need to use hospital-collected rather than independent or objective data sources. The TIPS results suggest that many of the barriers to achieving high rates of tPA delivery cannot be overcome solely using existing systems, existing workforce establishments, and clinical practice improvemen methodology. Some of the intervention functions referenced within the behavior change wheel, including incentivization and restriction, were not able to be used and may be necessary to achieve substantial and sustained change. Our intervention had a strong focus on clinician capability and motivation but was less able to influence opportunity, that is, the capacity of clinicians to engage with the intervention, because of their high and diverse workloads. A longer intervention period (as suggested by the secondary analyses) and greater intensity if the TIPS intervention activities may also be required, such as additional workshops and more peer-to-peer interaction.
Conclusion		
27. Regulatory approval, trial/study registration, funding, conflicts of interest	2, 12-3	The study was funded by a National Health and Medical Research Council Partnership Grant (569328), partially funded by a National Health and Medical Research Council Practitioner Fellowship (1043913) and National Health and Medical Research Translating Research into Practice Fellowship, and included Partnership Grant contribution funding from Boehringer Ingelheim, in-kind support from the Agency for Clinical Innovation Stroke Care Network/Stroke Services New South Wales, the National Stroke Foundation, and New South Wales Cardiovascular Research Network-National Heart Foundation with cash contribution from the Victorian Stroke Clinical Network and infrastructure funding from Hunter Medical Research Institute and The University of Newcastle. Disclosures from the authors include the receipt of support from National Health and Medical Research Council grant, cash contributions from Boehringer Ingelheim, the Victorian Stroke Clinical Network, and the New South Wales Cardiovascular Research Network-National Heart Foundation, and in-kind support from the Agency for Clinical Innovation Stroke Care Network/Stroke Services New South Wales, the National Stroke Foundation, and the New South Wales Cardiovascular Research Network-National Heart Foundation. Authors acknowledged funding from National Health and Medical Research Council grants, fees for advisory board membership at AMGEN, travel support and honoraria for speaking fees at Takeda, honoraria from Bayer for lecturing at sponsored scientific symposia, nonfinancial and travel support from Boehringer Ingelheim, fees from AbbVie. The trial was registered with the Australian New Zealand Clinical Trials Registry: ACTRN12613000939796 and has obtained a UTN number: U1111-1145-6762. Trial protocol has been published at https://doi.org/10.1186/1748-5908-9-38. Institutional review board approval was obtained from Hunter New England Health, University of Newcastle, Darling Downs Health Service, Sydney Adventist Hospital Group, Epworth HealthCare, LaTrobe Regional Hospital, Peninsula Health, and Melbourne Health Human Research Ethics Committees.

Abbreviations: CI: confidence interval; IVT: intravenous thrombolysis; mRS: modified Rankin Scale; NSF: National Stroke Foundation; PRACTISE: Promoting Acute Thrombolysis for Ischaemic Stroke; StaRI: Standards for Reporting Implementation Studies; TIPS: Thrombolysis Implementation in Stroke; tPA: tissue plasminogen activator

Table 6. StaRI checklist – Lynch 2015[a]

	Page	Implementation strategy How the intervention was implemented	Page	Intervention What was the healthcare intervention being implemented
StaRI criteria number				
Title and abstract				
1. Title		Protocol – Not identified as an implementation study in title. Study type – interventional Thesis – Implementing the Assessment for Rehabilitation Tool ... a mixed methods cluster randomised trial		
2. Abstract		Protocol Summary – Implementation: tailored implementation package consisting of identification of barriers and facilitators and development of site-specific strategies for implementation (identified in a workshop with health professionals as participants) to help improve rehabilitation assessment practices Protocol Summary – Intervention: The multifaceted intervention consists of a decision-making tool, education, audit and feedback, reminders and a tailored implementation package Protocol Summary – Outcomes: to assess proportions of patients assessed for rehabilitation, and proportions of patients who access rehabilitation. Thesis – Abstract: a multifaceted intervention which included multiple educational outreach visits, copies of the ART, tailored implementation strategies, use of opinion leaders, audit and feedback data and reminders. A single educational outreach visit was as effective as a multifaceted intervention for improving rehabilitation assessment practices for patients with stroke in Australian hospitals.		
Introduction				
3. Introduction	Thesis p xv	Australian clinical guidelines include the good practice point that every patient with stroke should be assessed for rehabilitation. National recommendations regarding how these assessments should be conducted were unavailable, until the Assessment for Rehabilitation Tool (ART) was developed in 2012. The ART is evidence-based, and was designed to objectively determine the rehabilitation requirements of patients with stroke. The ART was disseminated passively via email, and its impact on clinical practice was unclear.		
4. Rationale	Thesis p xv	Educational outreach visits and multifaceted interventions are more effective than passive dissemination of clinical guidelines for improving clinical practice.		The relative effectiveness of multifaceted interventions compared to educational outreach visits for multidisciplinary teams working in hospital settings is unknown.
5. Aims and objectives	Thesis p xv, p49, 50	To describe the factors related to implementation of the ART and to compare the effectiveness of an education intervention and a multifaceted intervention for improving rehabilitation assessment practices. To examine rehabilitation assessment practices for patients with stroke before and after the implementation interventions, and to evaluate the effectiveness of two implementation interventions (education and multifaceted intervention) for improving rehabilitation assessment practices in Australian hospitals.		
Methods (description)				
6. Design and key features	Thesis Figure 3.1, Figure 5.1	A mixed methods cluster randomised trial was designed to compare the effectiveness of two implementation interventions for improving rehabilitation assessment practices. Quantitative data were collected before and after the intervention period at all participating hospi-		

Table 6. StaRI checklist – Lynch 2015[a] *(Continued)*

		tals to determine the proportions of patients with stroke who were assessed for rehabilitation. The implementation interventions were developed using the Implementation of Change theoretical model		
7. Context of intervention	Thesis p54, 65	To be included in the trial, hospitals needed to admit more than 100 patients with stroke per year, and be located in metropolitan regions or have organised stroke services within South Australia. The education sessions were scheduled on the same day as baseline medical record audits at sites outside metropolitan South Australia		
8. Characteristics of target groups	Thesis p54	Clinicians from the ASUs, stroke nurses and rehabilitation team clinicians in the regional hospitals, and clinicians from the medical wards from one South Australian hospital which admitted more than 100 patients with stroke to the medical wards each year were participants .	Thesis p61	Medical records were included in the baseline audit for patients who were discharged from hospital consecutively between 1st October 2012 to 15th January 2014 with a diagnosis of stroke. Medical records were excluded for patients with a diagnosis of transient ischaemic attack or subarachnoid haemorrhage
9. Description of implementation strategy/intervention	Protocol	Multifaceted behaviour change intervention for health professionals working in acute stroke units. All sessions conducted onsite at acute hospitals. Comprised of: 1. education sessions: Two education sessions delivered onsite to acute stroke unit team by research physiotherapist (>10 years clinical experience). Both education sessions (duration 30-60 minutes) held within a 1 month period, participants were invited to attend both sessions. Education regarding Assessment for Rehabilitation Tool (rationale for use, how to use) provided. Up to 3 additional education sessions provided if this was nominated as a strategy by participants in the strategy development workshop 2. Printed educational materials: paper copies of the Assessment for Rehabilitation Tool, and 3 copies of Assessment for Rehabilitation Tool user manual provided to acute stroke unit teams. Information provided regarding freely available associated electronic resources 3. Audit and feedback: medical record audit conducted by research physiotherapist, site-specific feedback provided verbally and written (paper-version) summary of audit distributed to participants working on acute stroke unit by research PT re	Thesis p67	The multifaceted intervention consisted of two or more onsite education sessions, distribution of printed materials, audit and feedback, recruitment of a site champion, barrier identification and local strategy development, promotion of interdisciplinary teamwork and reminders. The education intervention consisted of one onsite education visit and distribution of printed materials.

Table 6. StaRI checklist – Lynch 2015[a] *(Continued)*

		proportions of patients assessed for rehabilitation, profiles of patients not assessed in audit, profiles of professionals who conducted the assessments in the audit, summary of assessment processes and access to rehabilitation 4. barrier identification and strategy development: workshops held with acute stroke unit team at each site (facilitated by research physiotherapist) to identify barriers to use of Assessment for Rehabilitation Tool, followed immediately by strategy development session (combined session 60 minute duration) 5. Site champions: each site nominated 1-3 site champions to lead implementation of strategies developed in workshop 6. reminders: 1-2 emails sent to all workshop participants by research team, monthly phone or email contact between research team and site champion for 4 months following initial education session (more contact if initiated by site champion) to discuss implementation of strategies.		
10. Subgroups or nested studies		None identified		
Methods (evaluation)				
11. Prespecified outcomes	Thesis p51	1. Both the education interventions and the multifaceted interventions would be effective for improving proportions of patients assessed for rehabilitation 2. The multifaceted intervention would be more effective than the education intervention for improving proportions of patients assessed for rehabilitation.	Thesis p51, 63	Research questions included: What proportion of patients with stroke who required rehabilitation did not access rehabilitation on discharge from the acute hospital? The primary outcome was documentation of a rehabilitation assessment, defined as documentation of a patient's suitability for rehabilitation The secondary outcome was access to rehabilitation following discharge from the acute hospital.
12. Process evaluation objectives and outcomes	Thesis p47, 50	Effective implementation strategies include printed educational materials, audit and feedback, education interventions, interventions tailored specifically to overcome previously identified barriers, use of local opinion leaders, reminders and interprofessional collaboration. An evidence-based decision-making tool to assist clinicians to determine the rehabilitation requirements of patients with stroke was developed and passively disseminated by a national body in Australia. Education interventions tend to be more effective than passive dissemination of printed educational materials for changing clinicians' behaviours. Multi-		

Table 6. StaRI checklist – Lynch 2015[a] *(Continued)*

		faceted interventions have been used successfully to change clinicians' behaviour on Australian ASUs. The benefits of multifaceted interventions over education interventions for changing the behaviours of clinicians providing care to patients with stroke remain unclear.		
13. Economic and resource cost		Not conducted		Not conducted
14. Sample size rationale	Thesis p61	Prior to the study, a power calculation was conducted to determine the number of medical records to audit, based on an anticipated moderate effect size in the group assigned to receive the multifaceted intervention. With alpha set at 5% and power at 80%, clustering effect of the 10 hospitals, the required sample size was 620 (310 at each time point).		
15. Methods of analysis	Thesis p77-78	Data analysis was performed in STATA. Descriptive analyses were conducted to determine the frequencies of rehabilitation assessments and access to rehabilitation. The changes over time in proportions of patients assessed for rehabilitation (both within each hospital and in the aggregated data) were analysed using Chi-squared tests. In order to compare the effectiveness of the two interventions, all outcomes were adjusted for pre-intervention levels and for clustering within hospitals. A logistic regression model was used that fitted within a generalised estimating equation framework. The models were refit using the identify link so that the intervention effect could be presented in differences in proportions with 95% confidence intervals. The RE-AIM framework (Reach, Effectiveness, Adoption, Implementation and Maintenance) which specifies aspects that should be considered when evaluating an implementation program was used to evaluate the current study. Use of the framework was indicated to facilitate a systematic, comprehensive evaluation of the overall implementation program. Relevant data from the pre-intervention studies, the implementation phase and from the post-intervention focus groups and medical record audit were mapped to the five components of the framework.		
16. A prior subgroup analysis or nested research tasks		A priori subgroup analyses not reported		
Results				
17. Characteristics of participants recruited	Thesis p79-80, Table 5.2	All eligible participants (i.e. clinicians and patients) agreed to participate in the research. Table 5.1 has details of participating hospitals and if received education or multifaceted intervention		Thesis Table 1 (p. 102)
18. Outcomes	Thesis Table 5.3, 5.8	Table 5.8 – Barriers and enablers associated with different reported rehabilitation assessment practices Table 5.3 – Barriers identified and strategies developed to improve rehabilitation assessment practices at participating sites	Thesis p 213-214 Tables 5.9 and 5.21	Only four of the 11 sites (ASU1, ASU7, ASU8, RH1) reported using the ART criteria when deciding who to recommend for rehabilitation. Participants at nine sites (all sites other than ASU4 and RH2) reported attempting to change how rehabilitation assessments were documented in order to capture this information. However, data from the medical record audit only identified six patients who were assessed as being in need of rehabilita-

Table 6. StaRI checklist – Lynch 2015[a] *(Continued)*

		tion who did not access rehabilitation on discharge from hospital.		
19. Process data	Thesis Table 5.7	Table 5.7 – Barriers and enablers to changing rehabilitation assessment practices, mapped to the Theoretical Domains Framework		
20. Resource use, costs, economic outcomes		Not conducted		Not conducted
21. Representativeness and outcomes of subgroups		Patient received rehabilitation assessment by hospital clinician, rehabilitation specialist or either (Table 3, p. 106), community dwellers only (Table 4, p. 107) and health service factors (Table 5, p. 108)		
22. Fidelity to implementation or intervention	Thesis p 49, 71	Adaptation part of the implementation strategy to tailor to each locale. The fifth stage of the Implementation of Change theoretical model developed by Grol and Wensing is Evaluation and adaptation of the plan when necessary As the trial progressed, information emerged about strategies that were reported to enhance rehabilitation assessment practices. When available, this information was incorporated into the education sessions for sites which participated in the interventions at later dates.	Thesis p 136	Interventions were delivered as intended at the majority of sites (ASU1, ASU2, ASU4, ASU5, ASU6, ASU8, RH1 and RH2). However, interventions were not delivered as initially planned at three sites assigned to receive the multifaceted intervention (ASU3, ASU7, MMW).
23. Contextual changes affecting outcomes		Not specifically reported.		
24. Harms or unintended effects		Not specifically reported		
Discussion				
25. Summary of findings, strengths, limitations, comparisons to other studies	Thesis p222-24	This study has provided evidence that a single educational outreach visit and provision of printed materials regarding the ART and the ART referral pathway was as effective as a multifaceted implementation intervention for improving proportions of patients with stroke who were assessed for rehabilitation. Comparing these results to data from the national audit over the time frame in which the educational materials were released, the two implementation interventions appeared to be more effective than passive dissemination of the resources alone. Strengths – The strengths of this study include the rigorous study design, the holistic evaluation and the methodological reporting processes that were used. The CONSORT statement for cluster randomised trials was used to plan the design and to guide the reporting of the cluster randomised trial. The study design, by incorporating mixed methods, allowed for factors such as clinician behaviour, process and patient outcomes, and the overall implementation to be evaluated. Two coders were used for all qualitative data analysis to ensure rigour. Data were collected from medical records by blinded assessors. Structured frameworks were used to guide the implementation intervention, the analysis of qualitative data regarding the factors that influenced a change in rehabilitation practices, and to evaluate the implementation intervention Limitations – Limitations of the study include that the intervention design did not include an intervention tailored for the rehabilitation specialist teams, or for medical professionals		

Table 6. StaRI checklist – Lynch 2015[a] *(Continued)*

		providing acute post-stroke care. Both of these professional groups have important roles and responsibilities regarding assessing patients with stroke for rehabilitation, so in future, specifically targeted implementation interventions are recommended to improve participation from these professional groups.		
26. Discussion of policy, practice or research implications	Thesis p224	Sustainability not referenced. Implications – Further plans to roll out the ART and the ART referral pathway should focus on the simpler, more time-efficient and equally effective intervention of the education outreach visit and distribution of printed materials to sites which are interested in improving rehabilitation assessment documentation for patients with stroke	Thesis p 214, 224	Sustainability not referenced. Implications – This project led to the inclusion of new questions regarding rehabilitation assessment practices in the national audit data tool. Data from the national audit can be used to evaluate whether improvements occur and are sustained in the long term. Thesis – All sites which chose not to use the ART (ASU4, ASU7, ASU8, RH2) reported that they considered its use would be time consuming.
Conclusion				
27. Regulatory approval, trial/study registration, funding, conflicts of interest	Protocol Thesis p55	Trial registered retrospectively on ANZCTR. Funding from Department of Education and Training, University of South Australia, NSW Agency for Clinical Innovation, National Stroke Foundation, SA Health. Three Human Research Ethics Committees approved the study (Approval numbers HREC/12/SAH/31, HREC/12/RPAH/523 and UniSA 30405). Site governance approval was provided at all participating hospitals.		

[a]Description of the StaRI checklist can found at https://www.bmj.com/content/356/bmj.i6795
Abbreviations: ANZCTR: Australian New Zealand Clinical Trials Registry; ASU: acute stroke unit; NIHSS: National Institutes of Health Stroke Scale; StaRI: Standards for Reporting Implementation Studies

Table 7. StaRI checklist – Middleton 2011[a]

	Page	Implementation strategy How the intervention was implemented	Page	Intervention What was the healthcare intervention being implemented
StaRI criteria number				
Title and abstract				
1. Title		Middleton 2009 Protocol – A cluster randomised trial of knowledge transfer Middleton 2011: Implementation of evidence-based treatment protocols, no keywords Middleton 2017: Implementation not identified in title, but included in keywords. Intervention included in title: Mortality Reduction for Fever, Hyperglycemia, and Swallowing Nurse-Initiated Stroke Intervention Drury 2014: Process evaluation of an intervention, behaviour change in keywords		
2. Abstract		Intervention – Middleton 2009: Study aims to develop and trial an intervention based on multidisciplinary team-building to improve management of fever, hyperglycaemia, and swallowing dysfunction in patients following acute stroke.		

Table 7. StaRI checklist – Middleton 2011[a] *(Continued)*

		Implementation – Middleton 2009: unit-based workshops to identify local barriers and enablers; a standardised core education program; evidence-based clinical treatment protocols; and ongoing engagement of local staff.		
Introduction				
3. Introduction	Middleton 2011 p1699	Although organised stroke unit care significantly reduces death and disability from cerebrovascular events, temperature, blood glucose levels and dysphagia are not yet universally well managed despite their importance for long-term patient recovery.International guidelines recommend that fever and high blood glucose concentrations be monitored and managed proactively and that every stroke patient have their swallowing status evaluated before receiving food, fluid, or oral medication. All these recommendations are the responsibility of the stroke multidisciplinary team, but care is not always consistent with these recommendations.		
4. Rationale	Middleton 2009 p5-6 Drury 2014 p765	The approach has drawn heavily from the implementation literature to incorporate promising strategies that have, in other settings, improved the provision of evidence-based clinical care. There was a deliberate focus on multidisciplinary team-building, by incorporation of early and widespread involvement of staff using formal facilitation methods; high quality training materials with timely on-the-job training; team-based training (as opposed to individual training); encouraging adaptation of the intervention to the local context; and involvement of staff in evaluating the success of local adoption of intervention. Process evaluations conducted parallel to or following RCTs to help interpret research results.	Middleton 2009 p2 Middleton 2011 p378	Elevation of blood glucose and body temperature in the early poststroke period are associated with significantly worse stroke outcomes. Management of swallowing dysfunction (dysphagia) also is crucial to reduce the risk of aspiration leading to chest infections, aspiration pneumonia and death. Fever, blood glucose levels and management of swallow were selected because they implicate multidisciplinary teamwork, which has been shown to improve health-care processes and patient outcomes.
5. Aims and objectives	Middleton 2009 p3 Middleton 2017 p1332 Drury 2014 p767	To evaluate the impact on patient outcomes of a multidisciplinary team-building intervention designed specifically to improve evidence-based management of fever, hyperglycaemia, and swallowing dysfunction in patients following acute stroke. To assess the impact of the Quality in Acute Stroke Care intervention on long-term all-cause mortality for patients in the postintervention patient cohorts To examine protocol adherence by measuring the proportion of patients managed according to the protocols.		
Methods (description)				
6. Design and key features	Middleton 2009 Figures 1 and 2	Both implementation and intervention The design and key features of the evaluation (cross-referencing to any appropriate methodology reporting standards), and any changes to study protocol, with reasons		

Table 7. StaRI checklist – Middleton 2011[a] *(Continued)*

	Middleton 2011 p179 Drury 2014 p767	Single-blind cluster randomised controlled trial randomised Acute Stroke Units (ASUs) to minimise contamination because the team building intervention was designed for implementation at the ASU level. Medical record audit to ascertain protocol adherence, using prospectively documented data for pre- and postintervention patient cohorts.		
7. Context of intervention	Middleton 2011 p 1700	ASUs eligible to participate were those located in large, tertiary referral centres in New South Wales (NSW), Australia, which provided care for stroke patients in a geographically defined location with immediate CT access and on-site high dependency units (n=20).		
8. Characteristics of target groups	Drury 2014 p 767	From July 2005 to October 2010, the QASC cluster RCT was conducted across 19 acute stroke units in New South Wales, Australia	Middleton 2009 p 3	Patients admitted to any of the consenting 20 ASUs in NSW will be eligible to participate Patient participants: a consecutive sample of English-speaking patients, aged >18 years, presenting within 48 hours of onset of symptoms who are given a clinical diagnosis of ischaemic stroke or intracerebral haemorrhage that is subsequently confirmed by CT imaging. Patients will be excluded if they present to the ASU 48 hours or greater following onset of symptoms, have noncerebrovascular causes of acute focal neurological deficits (seizure, hypoglycaemia, toxic or metabolic encephalopathies), subarachnoid haemorrhage, or acute and chronic subdural haemorrhage. Patients who require palliative care will not be approached.
9. Description of implementation strategy/intervention	Drury 2014	Two site-based teambuilding workshops were conducted prior to intervention focusing on identifying enablers and barriers to protocol uptake, development of teamwork, identifying champions, and local adaptation. Two interactive and didactic outreach educational sessions focusing on protocol orientation and staff education were also held in each unit. ASU staff was contacted every six weeks by the project manager, via a site visit. Telephone calls and or emails also acted as reminders. Protocol implementation and reminders continued over three-years from 2007 to 2010. Control groups received only an abridged version of existing guidelines and no educational	Middleton 2009 p 3 Middleton 2011 Panel 2	The intervention was designed to improve outcomes for patients admitted with acute stroke by better management of fever, hyperglycaemia, and swallowing dysfunction as recommended by evidence-based guidelines. The intervention comprised replicable steps to identify local barriers and enablers, unit-based education, feedback, and ongoing proactive support. intervention elements listed with clinical treatment protocols for management of fever, sugar, swallow by nurses for first 72 h of ASU care.

Table 7. StaRI checklist – Middleton 2011[a] *(Continued)*

		or implementation support.		
10. Subgroups or nested studies	Middleton 2011 p 1701	Auditors attended a 2-day training programme. Two auditors abstracted data from 95% of medical records, enabling clarification of uncertainties. Multiple independent auditors, telephone interviewers involved to complete research tasks		
Methods (evaluation)				
11. Prespecified outcomes		Specific targets for implementation outcomes not identified	Middleton 2009 p3	Comparing patients admitted to ASUs randomised to receive the FeSS intervention to patients treated in ASUs randomised to the control group: Primary hypotheses: that patients admitted to stroke units that received the intervention would have 12% lower death or disability at 90 days post-hospital admission (disability defined as mRS ≥ 2) 0.25 standard deviations lower mean disability (mRS) at 90-days post-hospital admission (0.5 units on mRS scale) 0.25 standard deviations lower mean dependency score at 90-days post-hospital admission (as measured by the Barthel Index) 0.25 standard deviations higher mean MCS and PCS SF-36 health status scores at 90-days post-hospital admission (2.5 units for PCS; 3.5 units for MCS). Secondary hypotheses That clinicians working on stroke units that received the intervention would demonstrate behaviour change 1. Improved glycaemic control as measured by: 0.25 standard deviations lower mean finger-prick blood glucose level (BGLs) for the first 72 hours following admission (while finger-prick BGLs are not the 'gold standard' measurement method for blood glucose, they are currently routinely used for monitoring in clinical practice) 2. Improved temperature control as measured by: 0.25 standard deviations lower mean temperature readings for the first 72 hours following admission to the ASU 3. Improved management of swallowing dysfunction as measured by: 13% increase in the proportion of swallowing screening undertaken within the first 24 hours of

Table 7. StaRI checklist – Middleton 2011[a] *(Continued)*

		admission to the ASU		
12. Process evaluation objectives and outcomes	Drury 2014 Boxes 1, 2 and 3	Process evaluation objectives and outcomes related to the mechanism by which the strategy is expected to work Outcome measures presented in detail		
13. Economic and resource cost		Not conducted		Not conducted
14. Sample size rationale	Middleton 2009 p 9	A sample of 250 per group would allow detection of a difference between groups of 12% (35% versus 23%) for the proportion of patients with death or disability (≥2 on the mRS) and a clinically meaningful difference in mean mRS of 0.5 (from 2 to 1.5, equivalent to a 25% change in mean score) with 80% power and a 5% (two-sided) significance level. This sample would also allow detection of differences between groups of at least 13% for binary outcomes and one-quarter of a standard deviation for continuous outcomes, with 80% power and a 5% (two-sided) significance level. Assuming a loss to follow-up of 10%, an effective sample size of 280 participants per group was required. These calculations assume independent observations. The authors devised a table to demonstrate statistical power according to various defensible estimates of intra-cluster correlation co-efficients (ICCs) for two patient outcomes. Estimated ICCs range from 0.01 to 0.03. Authors anticipated a design effect of 1.85, so aimed to recruit 520 patients per group (1,040 in total).		
15. Methods of analysis	Middleton 2011 p 1701	Intention-to-treat analysis for all outcomes with SAS v9·2 software. The Barthel index is usually reported as a dichotomised variable but the cut points vary; authors reported both Barthel indexes of 60 or more and of 95 or more, the two most conventionally reported cut points to allow for comparison with published data. Continuous and categorical data were summarised using conventional descriptive statistics. All outcomes were adjusted including the subgroup analyses for preintervention data and for clustering within ASUs using a logistic regression model fitted within a generalised estimating equation framework for dichotomous outcomes and a random intercept linear regression model for continuous out comes. The linear and logistic models included the predictor variables of period (before and after), intervention and the interaction between period and intervention. The p value from the Wald test for the interaction term was used to see if the pre-post change in the intervention group was statistically different to the change in the control group. The CIs reported are those for the interaction term from the logistic or linear model but to obtain estimates of absolute difference, the models for dichotomous outcomes were refit with an identity link function. The p values for the interaction term from these models were almost identical to the logistic models. To control the type 1 error rate from the four primary outcome measures, the α level was set at 0·0125. There were 19 clusters with a mean cluster size of 39 consenting patients in the pre-intervention cohort (median 31; minimum 10; maximum 83). In the post-intervention cohort the mean cluster size was 59 consenting patients (median 58; minimum 13; maximum 145). Authors achieved the desired sample size consistent with earlier statistical assumptions.		
16. A prior subgroup analysis or nested research tasks	Middleton 2017	Two a priori analyses were specified: (1) primary analysis: unadjusted for covariates and (2) secondary analysis: adjusted for age, sex, marital status, education, and stroke severity (Los Angeles Motor Scale)		
Results				
17. Characteristics of participants recruited	Dale 2015 p 43	Clinician participants pre- and postimplementation detailed in Table 1.	Middleton 2011 p 1702-3	Figure 2 has postintervention trial profile, and highlight box has control and intervention demographic and clinical characteristics.
18. Outcomes	Dale 2015 p 43	Preimplementation perceived barriers were centred on four categories:	Middleton 2011 p 1704)	Figure 3 has distribution of 90-day mRS for control and intervention groups, Table 2 has primary outcomes 90 d af-

Table 7. StaRI checklist – Middleton 2011[a] *(Continued)*

		policy, workforce, equipment and education.	Middleton 2017 p 1334	ter hospital admission and Table 3 has secondary outcomes, processes of care measures for fever, glucose and swallowing screening. Table 3: Cause of death by treatment group; Table 4: Risk of death by treatment group, age, stroke severity and marital status with Cox multivariable regression
19. Process data	Drury 2014 p 774	The process evaluation showed that significantly more patients were managed according to the fever, sugar, and swallow protocols, demonstrating a clear positive influence of the intervention on behavior change. Tables 3 through 6 have protocol adherence for FeSS, including sugar amongst known and unknown diabetic participants		
20. Resource use, costs, economic outcomes		Not conducted		Not conducted
21. Representativeness and outcomes of subgroups	Middleton 2011 p 1702, 1705 Middleton 2017 p 1333	19 (95%) ASUs agreed to participate. The length of time ASUs had been established before trial commencement was similar between intervention and control groups. Data for the pre-intervention patient cohort were published. Age, sex, 90-day death, 90-day death and dependency, 90-day functional dependency (BI), and health status (PCS score and MCS score) were similar for the intervention and control groups. Subgroup analyses showed significant improvements for death and dependency outcomes for both mild and severe strokes in the intervention group (14% in the mild stroke cohort and 16% in the more severe stroke cohort) showing a clear benefit for both mild and more severe strokes. Demographic and clinical characteristics for both groups were well balanced, with the possible difference that intervention group participants had a higher level of education compared with the control group.		
22. Fidelity to implementation or intervention		Not reported	Middleton 2011	No changes to published protocol reported
23. Contextual changes affecting outcomes		Not reported		
24. Harms or unintended effects		Not reported		
Discussion				
25. Summary of findings, strengths, limitations, comparisons to other studies	Middleton 2011 p 1706 Middleton 2017 p 1335 Drury 2014 p 774	Summary and strengths – The trial provides compelling evidence that better management of fever, hyperglycaemia, and swallowing in acute stroke patients during the initial 72 h of admission to an ASU can result in decreased rates of death, dependency, and improved processes of care. Further, the trial is one of the few to clearly show the effect of good nursing care on death and dependency. Additionally, it is one of the first implementation trials in acute stroke to harness the stroke unit network in Australia, and one of the largest multidisciplinary rigorously evaluated interventions in acute stroke. Limitations – As the intervention focused on care of patients admitted to ASUs, the findings are not necessarily generalisable to stroke patients cared for in general medical wards. They also are only generalisable to patients admitted to ASUs within 48 h of symptom onset and who receive the protocol-led care for the first 72 h after admission to an ASU. Demonstrated clinical significance of management of fever, hyperglycaemia and swallowing compared to other clinical and organisational interventions e.g. administration of aspirin within 48 h, stroke unit care, and thrombolysis within 4·5 h.		

Table 7. StaRI checklist – Middleton 2011[a] *(Continued)*

				Limitations – Methodologically, the mortality data are subject to the limitations of use of the NDI; however, the validity of this resource for ascertaining mortality has been established in many different populations. The exclusion criteria may have resulted in the under-representation of more severe strokes (although they were similarly distributed between treatment groups) and lower mortality rates in the trial cohort. The process evaluation shows that significantly more patients were managed according to the fever, sugar, and swallow protocols, demonstrating a clear positive influence of the intervention on behavior change. However, although protocol adherence significantly improved, management of fever, hyperglycemia, and swallowing dysfunction following stroke remained sub-optimal with low absolute rates in both groups.
26. Discussion of policy, practice or research implications	Drury 2014 p 775	Further investigations to identify barriers to treatment of of fever, hyperglycemia, and swallowing dysfunction in acute stroke patients recommended because the treatment remained sub-optimal following the implementation of the intervention.	Middleton 2011 p 1705 Middleton 2017	Compelling evidence provided that better management of fever, hyperglycaemia, and swallowing in acute stroke patients during the initial 72 h of admission to an ASU can result in decreased rates of death, dependency, and improved processes of care. One of the few trials to clearly show the effect of good nursing care on death and dependency. The importance of the intervention lies in its ability to augment the benefits of stroke unit care. Persuasive evidence provided that the benefits of nurse initiated multidisciplinary protocols for management of fever, hyperglycemia, and swallowing dysfunction when rigorously implemented has a sustained effect in reducing long-term mortality after discharge from stroke units.
Conclusion				
27. Regulatory approval, trial/study registration, funding, conflicts of interest	Middleton 2009 p 9 Middleton 2011 p 1700 Middleton 2017 p 1331	Include statement(s) on regulatory approvals (including, as appropriate, ethical approval, confidential use of routine data, governance approval), trial/study registration (availability of protocol), funding and conflicts of interest No competing interests by authors, The study was funded by a National Health and Medical Research Council Project Grant 353803. Use of TASC data was approved by the NSW Department of Health Ethics Committee. The trial was approved by the Human Research Ethics Committee of Australian Catholic University and the relevant ethics committees of all participating hospitals. The trial was governed by a steering committee including all investigators and an expert advisory committee consisting of independent researchers and stroke clinicians. The sponsors of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The study was funded by the National Health & Medical Research Council (Project Grant ID 353803), St Vincent's Clinic Foundation, the Curran Foundation, Australian Diabetes Society, the College of Nursing, and Australian Catholic University. Clinical Trial Registration—URL: http://www.anzctr.org.au. Unique identifier: ACTRN12608000563369. Disclosures: Dr Middleton was appointed to the Research Committee of the National Health & Medical Research Council (NHMRC) subsequent to trial completion. The following authors received research fellowship funding from the NHMRC: Dr Cadilhac (cofunded with Heart Foundation: 1063761) and C. Levi (Practitioner: 1043913). Dr Grimshaw holds a Canada Research Chair in Health Knowledge Transfer and Uptake. The other authors report no conflicts.		

[a]Description of the StaRI checklist can found at https://www.bmj.com/content/356/bmj.i6795

Abbreviations: ASU: acute stroke unit; CI: confidence interval; CT: computed tomography; FeSS: fever, sugar and swallowing dysfunction; mRS: modified Rankin Scale; RCT: randomised controlled trial; SF-36: 36-item Short Form Survey; StaRI: Standards for Reporting Implementation Studies

Table 8. StaRI checklist – Power 2014[a]

	Page	Implementation strategy How the intervention was implemented	Page	Intervention What was the healthcare intervention being implemented
StaRI criteria number				
Title and abstract				
1. Title	ISRCTN p. 1 Power 2014	Title references implementation via a stroke collaborative approach "Breakthrough series collaborative" keyword; Quality improvement collaborative in title		
2. Abstract	Power 2014	Implementation was via Stroke 90:10 – a quality improvement collaborative (QIC) based on the Breakthrough Series (BTS) model Intervention was two distinct care bundles to improve stroke care, one relating to early hours care and one relating to rehabilitation following stroke Key outcomes were that some aspects of stroke care improved, but modest effects only and that the extent to which a BTS QIC can improve quality of stroke care remains uncertain.		
Introduction				
3. Introduction	Power 2014 p 1, 2	Implementation deficiency is that QICs are used for improvement strategies, but they have mixed support on their effectiveness. Intervention problem is that there is dramatic variation in the care provided by different organizations, with nine evidence-based processes associated with improved outcomes identified		
4. Rationale	Power 2014 p 2	Power 2014 (p. 2) – Various models exist, with the BTS collaborative most widely used and often used to implement evidence-based processes grouped into care 'bundles' or composites of processes. There is also a theory that the bundle as a whole will achieve better results than the sum of its parts	ISRCTN p 1	Stroke can result in long-term disability or death. Stroke outcomes in the North West of England are amongst the worst in Europe.
5. Aims and objectives	ISRCTN p 1 Power 2014 p2	The primary aim of the study was to understand whether participation in a group learning environment increased compliance to stroke care bundles compared to not taking part. A secondary aim was to understand if joining an established learning environment would give results at a faster pace. To determine whether a quality improvement collaborative improves reliability of stroke care, i.e. whether hospitals participating in the Stroke 90:10 collaborative improved more than non-participating controls, as assessed by compliance with the two bundles of care.		
Methods (description)				
6. Design and key features	ISRCTN p1	The design and key features of the evaluation, (cross-referencing to any appropriate methodology reporting standards) and any changes to study protocol, with reasons		

Table 8. StaRI checklist – Power 2014[a] *(Continued)*

	Power 2014 p2	Cluster randomised controlled trial, Interventional, quality of life in hospital settings, with an interrupted time series design Participating hospitals in the North West of England were randomly allocated into two groups. One group used a quality improvement collaborative (QIC) (the intervention group) to share the learning regarding compliance with the bundles and the other group carried on using the methods they were using at that time (the control group).		
7. Context of intervention	Power 2014 p3	The context in which the intervention was implemented. (Consider social, economic, policy, healthcare and organisational barriers and facilitators that might influence implementation elsewhere.) Hospitals in the North West of England were stratified by stroke performance (Sentinel Audit score above or below 60) in the 12 months preceding baseline data collection (2007 and 2008).		
8. Characteristics of target groups	Power 2014 p 2	The characteristics of the targeted 'site(s)' (e.g locations/personnel/resources etc.) for implementation and any eligibility criteria. All NHS hospital Trusts in the Northwest of England were invited to participate based on the pre-defined inclusion criteria of: a minimum of ten inpatient dedicated stroke beds (a 'stroke unit'); agreement to participate signed by the chief executive; agreement to participate from a consultant in stroke medicine (or equivalent); a dedicated multidisciplinary stroke team; and availability of case notes for review. Exclusion criteria: Hospitals admitting fewer than 100 eligible patients per year, or unable to commit a dedicated team for participation.	Power 2014 p4	The population targeted by the intervention and any eligibility criteria. Once the QIC began in January 2009, intervention teams were asked to submit, every month, a complete registry of discharged patients coded for stroke from the previous month (based on ICD 10 codes 61, 63, and 64).
9. Description of implementation strategy/intervention	Power 2014 p 2	A description of the implementation strategy Stroke 90:10 collaborative (July 2008 through December 2010), support package (executive mentoring visits, access to project director, improvement advisor, web-based portal, weekly online sharing and learning sessions). Monthly reports to reflect on progress and review sessions, The Model for Improvement. Submitting data linked to the National Audit	Power 2014 Table 1	A description of the intervention Two care bundles for Stroke 90:10 covering brain imaging, aspirin/antiplatelet, swall screen, weight assessment and physio, OT, mood assessments, MDT goals, % stroke unit stay
10. Subgroups or nested studies		Any subgroups recruited for additional research tasks or nested studies are described None described		

Table 8. StaRI checklist – Power 2014[a] *(Continued)*

Methods (evaluation)

11. Prespecified outcomes		Defined prespecified primary and other outcome(s) of the implementation strategy, and how they were assessed. Document any predetermined targets None described	ISRCTN p 4	Defined prespecified primary and other outcome(s) of the intervention (if assessed) and how they were assessed. Document any predetermined targets PrImary: Adherence to the two bundles of processes and percentage of compliance to the bundles of care, known as 'all or none' measurement. Secondary: Process measures: hospitals in the intervention were asked to conduct a retrospective audit of up to 20 sets of stroke notes from the 6 months preceding the commencement of the collaborative and monthly thereafter, to obtain the following process measures: - Time between admission and brain scan and the percentage of patients scanned within 24 hours - Time between admission and delivery of 1st dose of aspirin and the percentage of patients receiving aspirin within 24 hours - Percentage of patients receiving a swallow screen within 24 hours - Percentage of patients weighed during their inpatient stay - Percentage of patients assessed by a physiotherapist within 72 hours - Percentage of patients assessed by an Occupational Therapist within 7 days - Percentage of patients spending 50% or more of admission on an Acute Stroke Unit - Percentage of patients receiving a mood assessment - Percentage of patients with multidisciplinary team goals reviewed weekly - Crude inpatient and 30 day mortality - Length of stay - 30-day readmission rate - 30-day Modified Rankin (assessment of residual disability / functional outcome)
12. Process evaluation objectives and outcomes	Power 2014 Table 1 Carter 2014 p 3-4	Process evaluation objectives and outcomes related to the mechanism by which the strategy is expected to work care bundle components are associated with improved patient outcomes, implementing the bundles will improve stroke care and subsequent patient outcomes Participants were asked about their experiences of the QIC, whether (and, if so, how) it had helped them to improve stroke care, and about the features of their organizations that af-		

Table 8. StaRI checklist – Power 2014[a] *(Continued)*

		fected their participation and performance in the collaborative. Those who took part in interviews included radiographers, stroke co-ordinators, specialist stroke nurses, occupational therapists, physiotherapists, healthcare assistants, data collection staff, emergency department staff, ward managers, and members of the hospital executive, reflecting the broad range of professionals involved in the QIC. As a secondary source of data, we also accessed project documents including reports and newsletters. These were purposively sampled mostly as a means of identifying background information about the collaborative, but also where appropriate as a way of triangulating emergent themes from the interview data.		
13. Economic and resource cost		Methods for resource use, costs, economic outcomes and analysis for the implementation strategy None described		Methods for resource use, costs, economic outcomes and analysis for the intervention None described
14. Sample size rationale	Power 2014 Carter 2014	Rationale for sample sizes (including sample size calculations, budgetary constraints, practical considerations, data saturation, as appropriate) Various power calculations conducted; Bundle 1 required 12 hospitals in each arm, Bundle 2 required 10 hospitals in each arm to identify compliance differences between control and intervention (various adherence rates) Semistructured Interviews with unknown number of team members, and 1 focus group with QIC faculty team		
15. Methods of analysis	Power 2014 p 4, 5	Methods of analysis (with reasons for that choice) Used a difference-in-difference approach to compare the differences between the intervention and control groups on bundle compliance. This approach measures the difference in bundle compliance over time (before and after the intervention) for the intervention group compared with the difference over the same period for the control group. Difference in relative average bundle compliance in the last three months of the baseline period (October 2008 to December 2008) compared with the last three months of the collaborative (October 2009 to December 2009).		
16. A priori subgroup analysis or nested research tasks		Any a priori subgroup analyses (e.g. between different sites in a multicentre study, different clinical or demographic populations) and subgroups recruited to specific nested research tasks None described		
Results				
17. Characteristics of participants recruited	Power 2014 p 5	Proportion recruited and characteristics of the recipient population for the implementation strategy Of the 25 eligible trusts in the Northwest of England, 24 (covering 30 hospitals) agreed to participate and were randomized.	Power 2014 p4-5, Table 2	Proportion recruited and characteristics (if appropriate) of the recipient population for the intervention Random samples of 20 patients per month per hospital were used to generate data for both the intervention period (July 2008 to December 2009) and baseline preintervention period (July 2008 to December 2008). 3533 patients in the intervention arm and 3059 patients in the control arm. Gender, comorbidities and risk factors between control and intervention groups described

Table 8. StaRI checklist – Power 2014[a] *(Continued)*

18. Outcomes	Carter 2014	Primary and other outcome(s) of the implementation strategy Improvements in stroke care were attributed to QIC participation by many professionals. They described how the QIC fostered a sense of community and increased attention to stroke care within their organizations. Collaborative advantages identified included motivating change, securing improvement through collaborative participation, with efforts required to collaborate identified, inequalities and competition as a source of tension, intraorganizational support variability	Power 2014, Table 3	Primary and other outcome(s) of the Intervention (if assessed) Proportion of patient receiving bundle pre- and post-, and ORs (95% CIs) reported. Bundle 1 significant improvement, driven by 1 (weighed during hospital admission) of 4 components; Bundle 2 significant improvement driven by 2 (mood assessment and rehab goals/MDT) of 5 components
19. Process data		Process data related to the implementation strategy mapped to the mechanism by which the strategy is expected to work		
20. Resource use, costs, economic outcomes		Resource use, costs, economic outcomes and analysis for the implementation strategy Not conducted		Resource use, costs, economic outcomes and analysis for the intervention Not conducted
21. Representativeness and outcomes of subgroups		Representativeness and outcomes of subgroups including those recruited to specific research tasks Not described		
22. Fidelity to implementation or intervention	power 2014 p 6	Fidelity to implementation strategy as planned and adaptation to suit context and preferences The collaborative program was run as designed. However, hospital sites did not consistently audit 20, or all, patients each month. A small number of hospitals were excluded for having a reporting rate under 50%; this was pre-specified in the protocol.	Power 2014 p6	Fidelity to delivering the core components of intervention (where measured) Average Bundle 1 compliance in the control group at baseline (October 2008 to December 2008) was 24.3%, rising to 37.5% by study end (Figure 3). In the intervention group, compliance was 19.6% at baseline, rising to 42.3% by study end.
23. Contextual changes affecting outcomes	Power 2014 p 6	Contextual changes (if any) which may have affected outcomes Unprecedented national and regional attention on stroke coincided with the period of study. During this time, managed clinical networks for stroke were being developed, a National Audit Office report was published and the Department of Health Stroke Improvement program was launched. Delivery of thrombolysis was a national target, and the basic processes required for success in achieving this were closely linked to the processes of care packaged into our Early Hours bundle.		
24. Harms or unintended effects	Power 2014 p8	All important harms or unintended effects in each group		

Table 8. StaRI checklist – Power 2014[a] *(Continued)*

		None described. Limitations included that study was not designed to identify unintended consequences		
Discussion				
25. Summary of findings, strengths, limitations, comparisons to other studies	Carter 2014 p7,8	Summary of findings included: general improvement over time across control and intervention groups. Limitations included: not all clinical processes of care captured, data collection and completeness rates between hospitals varied, generalisation beyond English context is limited, improved patient outcomes as a result were not part of study design, more sophisticated evaluation may be required to evaluate sociotechnical interventions Summary of findings identified advantages and disadvantages of QICs; limitations included: the study was conducted as the quantitative findings had begun to emerge, but interviews were not, as would have been ideal, undertaken concurrently with the collaborative. Issues with recall may therefore have occurred. It was not possible to undertake a formal check on theoretical saturation as the opportunities for theoretical sampling were constrained by availability of participants, so authors could not be certain that the findings are generalizable across all participants in Stroke 90:10.		
26. Discussion of policy, practice or research implications	Carter 2014 p9	Many participants attributed added value to the QIC and viewed it as a powerful mechanism for quality improvement. But the findings highlight aspects of QICs that, though well known in the literature on collective action, have been under-recognized in relation to quality improvement.	8	The study suggests that the answer to whether a Breakthrough Series QIC can deliver the extra boost needed to induce improvement beyond secular trend is not straightforward. It does appear to support improvement in more consistent delivery of some processes of care grouped into bundles, but additional, or other kinds of, support may be needed for more complex organizational challenges. Our study reinforces the need, when researching health service improvements, for controlled studies using difference-indifference analyses to avoid mistaking secular trends for treatment effects. Delivering consistently high quality of stroke care remains a key challenge.
Conclusion				
27. Regulatory approval, trial/study registration, funding, conflicts of interest	ISRCTN p1-3, Power 2014 p3 Carter 2014 p3	Include statement(s) on regulatory approvals (including, as appropriate, ethical approval, confidential use of routine data, governance approval), trial/study registration (availability of protocol), funding and conflicts of interest In the first year of the study, the two groups used the different systems. In the second year of the study both groups used the QI collaborative system. The intervention group worked with the control group to help them learn the new system. Funding was provided by The Health Foundation (UK), with an extension granted in October 2010. Protocol /serial number 2008neuro12 The study was approved by Tameside and Glossop Research Ethics Committee (Ref: 08/H1013/55) and was registered as a clinical trial with the International Standard Randomized Controlled Trial Number Register (Ref: ISRCTN13893902). Carter 2014: Research ethics committee approval was obtained for the qualitative study separately from the ethics approval for the QIC. ... Eleven hospitals agreed to take part and completed the necessary governance approvals to allow the study to take place.		

[a]Description of the StaRI checklist can found at https://www.bmj.com/content/356/bmj.i6795

Abbreviations: BTS: Breakthrough Series; CI: confidence interval; MDT: multidisciplinary team; N/A: not applicable; OR: odds ratio; QI: quality improvement; QIC: quality improvement collaborative; RCP: Royal College of Physicians; StaRI: Standards for Reporting Implementation Studies

Table 9. StaRI checklist – Shrubsole 2018[a]

	Page	Implementation strategy How the intervention was implemented	Page	Intervention What was the healthcare intervention being implemented
StaRI criteria number				
Title and abstract				
1. Title	1	"Use acute aphasia implementation" specifies the study as implementation study		
2. Abstract	1	Two interventions; Intervention A (targetted at improving information provision) and Intervention B (targeted at improving collaborative goal setting)		
Introduction				
3. Introduction	3	Specifies a tailored, theory-informed behaviour change intervention can be developed aimed at improving SLTs' aphasia management practices		
4. Rationale	3	There is emerging evidence of the barriers to SLTs performing guideline-recommended aphasia management practices.	3	Goal setting; information, education and aphasia-friendly information and conversation partner training
5. Aims and objectives	5	Tailored implementation strategy to improve SLTs' uptake of evidence in one of two areas of practice in the acute hospital setting (Intervention A=aphasia-friendly information provision; and Intervention B=collaborative goal setting)		
Methods (description)				
6. Design and key features	6	Multifaceted implementation interventions were designed to target previously identified barriers that were mapped to the Behaviour Change Wheel		
7. Context of intervention	8	Acute stroke care area		
8. Characteristics of target groups		Clusters of departments within hospitals. SLT teams from acute hospitals from Queensland and New South Wales, Australia were eligible to participate if there was at least 1 SLT providing management to people with acute poststroke aphasia		Not reported
9. Description of implementation strategy/intervention	6	Multifaceted implementation interventions used to design successful behaviour change interventions	6	Education Persuasion Environmental restructuring

Table 9. StaRI checklist – Shrubsole 2018[a] *(Continued)*

				Modelling Enablement
10. Subgroups or nested studies	5	The crossover design nested within the cluster random controlled trial		
Methods (evaluation)				
11. Prespecified outcomes	8	The primary outcome measure was the change in the targeted behaviour as determined by a medical record audit, which will be referred to at the audit change score		Improvement in information provision and goal setting
12. Process evaluation objectives and outcomes	8	Medical records were audited		
13. Economic and resource cost		Not reported		Not reported
14. Sample size rationale		Not reported		
15. Methods of analysis	9	Between-group pre-postanalysis on the primary outcome measure (audit change score) was used to determine if the intervention was successful using Fisher's exact test of independence.		
16. A prior subgroup analysis or nested research tasks		Not reported		
Results				
17. Characteristics of participants recruited	10	The majority of participants were female (36/37 = 97.3%), entry-level clinicians (15/37 = 40.5%), with a mean age of 30 years (Table 4)	11	Behavioural outcomes
18. Outcomes	16	Statistically significant changes in the targeted domains were seen post-intervention for both intervention arms.	16	For Intervention B, there were statistically significant improvements in the targeted domains of Beliefs about Capabilities (p = 0.001)
19. Process data	14	Environmental restructuring		
20. Resource use, costs, economic outcomes		Not reported		Not reported
21. Representativeness and outcomes of subgroups		Not reported		

Table 9. StaRI checklist – Shrubsole 2018[a] *(Continued)*

22. Fidelity to implementation or intervention	1	Outcomes addressed the research questions of feasibility (e.g. treatment fidelity and retention of participants)		Not reported
23. Contextual changes affecting outcomes	16	Studied how environmental structuring affect process of intervention		
24. Harms or unintended effects		Not reported		
Discussion				
25. Summary of findings, strengths, limitations, comparisons to other studies	20	It is unknown what impact the practice changes had on patient outcomes, as these outcome measures were not included in the design of the study		
26. Discussion of policy, practice or research implications	20	This has implications for SLT departments and health services alike, highlighting the importance of identifying barriers before embarking on implementation efforts	20	Implementation research in the field of aphasia management needs to take into account clinicians' priorities for aphasia management practices that they wish to improve, and how to sustain these practice changes over time
Conclusion				
27. Regulatory approval, trial/study registration, funding, conflicts of interest	20	Tailored theoretically based implementation intervention targeting acute SLTs' aphasia management practices is feasible, acceptable and potentially effective The authors report no conflicts of interest The study was approved by the Human Research Ethics Committee (HREC/16/QPAH/52)		

[a]Description of the StaRI checklist can found at https://www.bmj.com/content/356/bmj.i6795
Abbreviations: SLT: speech and language therapy; StaRI: Standards for Reporting Implementation Studies

Table 10. StaRI checklist – Wang 2018[a]

	Page	Implementation strategy How the intervention was implemented	Page	Intervention What was the healthcare intervention being implemented
StaRI criteria number				
Title and abstract				
1. Title	1	Effect of a Multifaceted Quality Improvement Intervention on Hospital Personnel Adherence to Performance Measures in Patients With Acute Ischemic Stroke in China – identified implementation of QI methods as the intervention.		

Table 10. StaRI checklist – Wang 2018[a] *(Continued)*

2. Abstract	1	Identification as an implementation study and evidence-based Ix being implemented: Twenty hospitals received a multifaceted quality improvement intervention (intervention group; 2400 patients), including a clinical pathway, care protocols, quality coordinator oversight, and performance measure monitoring and feedback. Implementation strategy not described Key implementation and health outcomes: The primary outcome was hospital personnel adherence to 9 AIS performance measures, with co-primary outcomes of a composite of percentage of performance measures adhered to, and as all-or-none. Secondary outcomes included in-hospital mortality and long-term outcomes (a new vascular event, disability [modified Rankin Scale score, 3-5], and all-cause mortality) at 3, 6, and 12 months.		
Introduction				
3. Introduction	2	Stroke is the leading cause of death and adult disability in China... Large-scale randomized trials and systematic reviews have established the efficacy of several performance measures for acute ischemic stroke... However, adherence to these evidence-based performance measures is suboptimal and gaps in adherence to guideline-recommended care are even greater in China.		
4. Rationale	2	Multifaceted quality improvement interventions that address the barriers to care are effective in changing physician practices. Quality improvement interventions have demonstrated that stroke care quality can be improved by conducting interventions such as using clinical pathways, training physicians on evidence-based guidelines, auditing care delivery, and providing timely feedback. Nevertheless, previous cluster-randomized studies in this area have had conflicting results. Some studies have demonstrated significant improvements in health care quality from quality improvement interventions, whereas others have found no significant effect. Randomized clinical trials have not been used to assess the effectiveness of multifaceted quality improvement interventions of stroke care in developing countries, which have up to 78% of the global burden of stroke.	2	Based on effective existing performance measures: intravenous recombinant tissue plasminogen activator (rtPA or alteplase), antiplatelet therapy, and anticoagulation for patients with atrial fibrillation
5. Aims and objectives	2	A cluster-randomized clinical trial called Intervention to Bridge the Evidence-based Gap in Stroke Care Quality (GOLDEN BRIDGE—AIS) was conducted to examine the effectiveness of a multifaceted quality improvement intervention on hospital personnel adherence to evidence-based performance measures [implementation outcome] and outcomes in patients [intervention outcomes] with acute ischemic stroke (AIS) in China.		
Methods (description)				
6. Design and key features	2, 3	Design and key features: an open-label, cluster-randomised clinical trial, with baseline survey → randomisation and blinding → QI interventions, including monitoring and feedback No change to study protocol, based on 2018 Suppt 1 or 2015 protocol paper		
7. Context of intervention	2, 3	Intervention undertaken in hospitals that were part of the Chinese Stroke Center Alliance, in larger public hospitals (secondary and tertiary grade hospitals) with stroke and tPA-delivery		

Table 10. StaRI checklist – Wang 2018[a] *(Continued)*

		facilities. Province, hospital size and baseline stroke care included in stratification for randomisation, but not further commented on		
8. Characteristics of target groups	2, 3	Hospitals were enrolled from the China National Network of Stroke Research (now the Chinese Stroke Center Alliance). Only secondary (serving several communities) or tertiary (hospitals for a central district or city) public hospitals in urban areas, with emergency departments (EDs) and neurological wards that admit patients with stroke and had the capacity to administer intravenous rtPA were eligible to participate. Staff involved: personnel who took care of patients with stroke.	2	Patients with AIS... 18 years or older with AIS confirmed by brain computed tomography scan or magnetic resonance imaging within 7 days after symptom onset and admitted to wards directly or through the ED were included.
9. Description of implementation strategy/intervention	3	The multifaceted quality improvement intervention included an evidence-based clinical pathway, written care protocols for implementation of performance measures, a full-time quality coordinator, and a monitoring and feedback system for performance measures.	3	Eevidence-based clinical pathway integrated into the care plan of each eligible stroke admission. Pathway based on peer-reviewed literature, consensus statements and guidelines. Written care protocols for IV-rt-PA, DVT prophylaxis, swallowing dysfunction and medication protocols were used to measure healthcare staff performance.
10. Subgroups or nested studies		No subgroups		
Methods (evaluation)				
11. Prespecified outcomes	3	Implementation outcomes were adherence to the 9 predefined evidence-based performance measures in people with AIS.	3	Patient outcomes included receiving the evidence-based performance measures. Secondary outcomes included in-hospital death, a new clinical vascular event, disability, all-cause mortality at 3, 6, and 12 months after initial symptom onset.
12. Process evaluation objectives and outcomes	3	Adherence to the 9 predefined evidence-based performance measures in patients with AIS: intravenous rtPA treatment within 3 hours of symptom onset, early use of antithrombotics, dysphagia screening, DVT prophylaxis, use of antithrombotics, anticoagulation for patients with atrial fibrillation or flutter, use of a lipid-lowering agent, use of antihypertension medication, and treatment of diabetes at discharge		
13. Economic and resource cost		Nil economic evaluation		Nil economic evaluation
14. Sample size rationale	4	A total of 4800 patients at 40 hospitals (considering a median of 120 patients with AIS per hospital) would be required to detect a 5% improvement in the composite evidence-based		

Table 10. StaRI checklist – Wang 2018[a] *(Continued)*

		performance measures in patients with AIS, with 80% power, 5% significance level, and an intracluster correlation coefficient (ICC) of 0.02. According to this predefined sample size, each group was required to enroll 2400 patients.		
15. Methods of analysis	4	Intention-to-treat analysis used for all outcomes. Continuous variables were summarised as median with interquartile ranges and categorical variables as frequency and percentage. Continuous and categorical data were analysed using Wilcoxon rank-sum test and χ2 test separately. With all comparative outcomes, cumulative incidences and absolute differences with 95% CIs were presented and adjusted by patient and hospital baseline characteristics. Modes were used to impute missing values of categorical variables, and medians were imputed for missing values of continuous variables. Multivariable regression models were performed to compare the outcomes between intervention and control groups. Generalized estimating equations were used to account for within-hospital correlation. Logistic regression was performed for the binary all-or-none measure and disability outcomes. The effects of intervention were expressed as a population average odds ratio. A mixed-model with a binary link function was used for 3-, 6-, and 12-month disability. A sensitivity analysis that included patients with contraindications for evidence-based interventions in the denominator of the overall population was conducted. All multivariable models were adjusted for patient characteristics and hospital characteristics. All secondary analyses were interpreted to be exploratory. A P value less than.05 was considered statistically significant; all tests were 2-sided. All statistical analyses were performed by using SAS (SAS Institute), version 9.3.		
16. A prior subgroup analysis or nested research tasks	N/A	No subgroup analysis		
Results				
17. Characteristics of participants recruited	4, 6, Table 1	From these participating hospitals, 72.5% were tertiary hospitals, 62.5% had a stroke unit, 62.5% were teaching hospitals, and the median annual number of beds of neurological wards was 77 (IQR, 61-178). Hospital characteristics were balanced between intervention and control groups except for length of stay.	4, 6, Table 1	The mean age of the patients enrolled was 65 years and 36.6% were women. The mean number of patients in each cluster was 120 (range, 102-145). Patient characteristics were balanced between intervention and control groups except for length of stay.
18. Outcomes	7, Table 2	Implementation outcomes were adherence to the 9 predefined evidence-based performance measures in people with AIS.	8, Table 3	Patient outcomes: in-hospital death, a new clinical vascular event, disability and all-cause mortality at 3, 6, and 12 months after initial symptom onset.
19. Process data		No process evaluation of implementation or intervention		
20. Resource use, costs, economic outcomes		Not reported		Not reported
21. Representativeness and out-		Not reported		

Table 10. StaRI checklist – Wang 2018[a] *(Continued)*

comes of subgroups				
22. Fidelity to implementation or intervention		Not reported		Not reported
23. Contextual changes affecting outcomes		Not reported		
24. Harms or unintended effects	5	Symptomatic intracerebral hemorrhage in patients receiving intravenous rtPA did not differ significantly between the intervention and control groups (2.2% [1 of 46 patients] in the intervention group vs 8.7% [2 of 23 patients] in the control group, P = .26).		
Discussion				
25. Summary of findings, strengths, limitations, comparisons to other studies	5 to 9	In this cluster-randomized clinical trial, a multifaceted quality improvement intervention compared with usual care resulted in a statistically significant but small improvement in hospital personnel adherence to evidence-based performance measures in patients with acute ischemic stroke when assessed as a composite measure, but not as an all-or-none measure. These quality improvement interventions significantly improved short-term and long-term outcome in reductions of new vascular events and reduced stroke disability. Strengths: use of c-RCT to reduce contamination, blinding of allocation and data collectors, ITT analysis Limitations: hospitals were recruited from a stroke network and may be more motivated to improve stroke care compared to hospitals outside of this network; external validity; 11-month QI project time may need to be extended to examine long-term effects; performance measurements used were focused on medical management and should be extended to other public health outcomes, such as education and behaviour change counselling Study was compared to the American Get with the Guidelines program and Target: Stroke as QI strategies and other c-RCTs utilising QI strategies with mixed results.		
26. Discussion of policy, practice or research implications	5, 6, 9	This study focused on improving the quality of care for patients admitted to public hospitals in China who have fewer resources and lower personal income than patients represented in prior studies from Western Europe and the United States. Public hospitals are the main source of physicians, accounting for 92% of hospital admissions in China. These public hospitals are overcrowded with patients and have limited resources. These findings suggest that despite these limitations, quality improvement interventions are feasible and could still be successful. Furthermore, these interventions are simple and do not require expensive technology or complex medical intervention. Among 40 hospitals in China, a multifaceted quality improvement intervention compared with usual care resulted in a statistically significant but small improvement in hospital personnel adherence to evidence-based	5, 6	No conclusions made about the current Ix – based on evidence-based protocols and guidelines, no need to change these

Table 10. StaRI checklist – Wang 2018[a] *(Continued)*

		performance measures in patients with acute ischemic stroke. However the differences at the level of each individual performance measure between the 2 groups did not reach significance. The performance on the all-or-none measure was not better in the hospitals receiving quality improvement intervention in this trial. Longer-lasting interventions might be needed to identify a significant difference in the all-or-none measure.
Conclusion		
27. Regulatory approval, trial/study registration, funding, conflicts of interest	1, 2, 9, 10	The trial protocol was approved by the central institutional review board at Beijing Tiantan Hospital. In addition, all participating clusters received the approval by their local research ethics board. Conflicts of interest: Dr Bettger reported consulting for the Ohio Department of Health and serving on committees for the Centers for Disease Control and Prevention (CDC) Paul Coverdell National Acute Stroke Stroke Registry. Dr Peterson reported being a principal investigator of the data coordinating and analysis center for the American Heart Association/American Stroke Association's Get With the Guidelines (GWTG). Dr Fonarow reported being a member of the GWTG steering committee and receiving grant funding from Patient-Centered Outcomes Research Institute and the National Institutes of Health. Dr Schwamm reported being the chair of the GWTG-Stroke Clinical Workgroup of the American Heart Association and principal investigator of a National Institute of Neurological Disorders and Stroke (NINDS)–funded clinical trial; grant funding and nonfinancial support from Genentech; and consulting for the Joint Commission, CDC, and the Massachusetts Department of Public Health. No other disclosures were reported. ClinicalTrials.gov Identifier: NCT02212912 Funding/Support: This study was supported by grants from the Ministry of Science and Technology and the Ministry of Health of the People's Republic of China, Beijing Municipal Committee of Science and Technology, Beijing Institute for Brain Disorders, Beijing Key Laboratory for Cerebrovascular Disease, University of Hong Kong Stanley Ho Alumni Challenge Fund; University of Hong Kong Research Committee Seed Funding Award and Sanofi. Dr Yilong Wang had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

[a]Description of the StaRI checklist can found at https://www.bmj.com/content/356/bmj.i6795
Abbreviations: AIS: acute ischaemic stroke; CI: confidence interval; c-RCT: community-randomised controlled trial; DVT: deep venous thrombosis; ITT: intention-to-treat; IV: intravenous; QI: quality improvement; rtPA: recombinant tissue plasminogen activator; StaRI: Standards for Reporting Implementation Studies

Table 11. Complexity of the targeted professional performance change

Study	Stated purpose of targeted change	Nature of desired change	Complexity of targeted change
Dirks 2011	Medical intervention (treatment with thrombolysis)	increase	high
Levi 2020	Medical intervention (treatment with thrombolysis)	increase	high
Lynch 2016	Planning for discharge (assessment for rehabilitation)	increase	high
Middleton 2011	Preventing complications (swallow screen)	increase	high

Table 11. Complexity of the targeted professional performance change *(Continued)*

Power 2014	Composite quality indicator (brain scan, aspirin, swallow screen, weighed)	increase	high
Shrubsole 2018	Goal setting and early rehabilitation (collaborative goal setting) and planning for discharge (information provision)	increase	moderate
Wang 2018	Composite quality indicator (treatment with thrombolysis, early antithrombotics, swallow screen, DVT prophylaxis, antithrombotics on discharge, anticoagulation for atrial fibrillation, lipid lowering medication, antihypertensive medication, antidiabetic medication)	increase	high

Abbreviations: DVT: deep venous thrombosis

Table 12. Comparison 2. Uptake or increase in acute medical interventions

Intervention	Outcome	Study	Type of study	Absolute postintervention difference	Postintervention level in control group	Effect after adjusting for preintervention levels and for clustering within participating sites OR (95% CI)
Intervention meetings based on Breakthrough Series	Treatment with thrombolysis (%)	Dirks 2011	cluster randomised trial	0.9%	12.2%	1.25% (0.93 to 1.68)
	Treatment with thrombolysis in participants with ischaemic stroke admitted within 4 h of symptom onset (%)			5.1%	39.3%	1.58% (1.11 to 2.27)
	Door-to-needle time in participants with ischaemic stroke admitted within 4 h of symptom onset (minutes)			−3	73	−3 (−15 to 10)
Multifaceted implementation package	Treatment with thrombolysis for acute ischaemic stroke (%)	Levi 2020	cluster randomised trial	0.8%	7.9%	1.1% (−1.5 to 3.7)
	Door-to-needle time for thrombolysis, (minutes, post hoc analysis)			4.75 min	80.08 min	8.33 (−8.10 to 24.76)
	Proportion of participants who received thrombolysis within 60 min of hospital arrival (% post hoc analysis)			2.2%	28%	1.01 (0.47 to 2.17)

Abbreviations: CI: confidence interval; OR: odds ratio

Table 13. Comparison 2. Uptake or increase in interventions to prevent complications

Intervention	Outcome	Study	Type of study	Absolute postintervention difference	Postintervention level in control group	Effect after adjusting for preintervention levels and for clustering within participating sites. Absolute mean difference (95% CI)
Treatment protocols to manage fever, hyperglycaemia and swallowing dysfunction with multidisciplinary team building workshops to address implementation barriers	Proportion of participants with stroke meeting all swallow care elements (%)	Middleton 2011	cluster randomised trial	36.1%	3.9%	13% (5.5 to 21)
	Proportion of participants with stroke meeting all blood glucose care elements (%)			3.0%	0.6%	3.6% (0.8 to 6.3)
	Proportion of participants with stroke meeting all fever care elements (%)			15.5%	15.3%	14.8% (7.9 to 22)
	Patient temperature monitored and charted during first 72 h of stroke unit admission (%)			18.2%	18.6%	15.0% (7.9 to 22)
	Participants with temperature > 37.5 treated with paracetamol (%)			5.4%	82.2%	12.2% (5.0 to 20)
	Formal (venous) blood glucose meare on admission to hospital (%)			14.1%	17.4%	23.8% (16 to 31)
	Finger-prick blood glucose on admission to stroke unit (%)			18.6%	13.2%	8.8% (0.7 to 17)
	Finger-prick blood glucose every 1 to 6 h for first 72 h depending on previous value (%)			22.7%	9.5%	24.0% (17 to 31)
	Saline infusion started if blood glucose 8 to 11 mmol/l (if patient is diabetic) or 8 to 16 mmol/l (if participant was not diabetic) (%)			−1.8%	93.2%	0.2% (−4.7 to 5.1)

Table 13. Comparison 2. Uptake or increase in interventions to prevent complications *(Continued)*

	Inlin infusion started if blood glucose ≥ 11 mmol/l (if participant was diabetic) or ≥ 16 mmol/l (if participant was not diabetic) (%)	−0.3%	97.5%	−1.4% (−4.3 to 1.6)
	Swallow screen within 24 h of admission (%)	39.6%	6.8%	29% (22 to 36)
	Referred to speech pathologist if failed swallow screen (%)	21.8%	26.1%	14% (5.6 to 21)

Abbreviations: CI: confidence interval;

Table 14. Comparison 2. Composite improvement outcomes (spanning multiple categories)

Intervention	Outcome	Study	Type of study	Absolute postintervention difference	Absolute preintervention difference	Postintervention level in control group	Percent relative improvement. OR (95% CI)
Quality improvement collaborative based on the Breakthrough Series model	Composite of 4 quality-of-care outcomes on or within 24 h of admission: • Brain scan • Aspirin • Swallow screen • Weight assessment	Power 2014	cluster randomised trial	4.8%	−4.7%	37.5%	10.9% (95% CI 1.3 to 20.6)
Evidence-based clinical pathway, protocols for implementation full-time quality coordinator and a monitoring and feedback system. Training in quality improvement methods.	Composite score of adherence to bundle of 9 quality-of-care indicators. Measured as total number of eligible measures performed divided by the total number of measures for which patient was eligible • IV-rtPA administration within 3 h of symptom onset • Antithrombotics within 48 h of admission • Dysphagia screening • Deep vein thrombosis prophylaxis • Antithrombotics prescribed at hospital discharge • Anticoagulants for atrial fibrillation prescribed at hospital discharge • Statins for high blood cholesterol prescribed at hospital discharge • Antihypertensives prescribed at hospital discharge • Hypoglycaemic medication for diabetes prescribed at hospital discharge	Wang 2018	cluster randomised trial	Stroke-unit-only data not available			
	Adherence to bundle of 9 quality-of-care indicators – all-or-nothing score (proportion of participants who received all of the performance measures for which the patient was eligible)	Wang 2018	cluster randomised trial	Stroke-unit-only data not available			

Abbreviations: CI: confidence interval; IV: intravenous; OR: odds ratio; rtPA: recombinant tissue plasminogen activator

Table 15. Comparison 2. Patient outcomes

Intervention	Outcome	Study	Type of study	Absolute postintervention difference	Postintervention level in control group	Effect after adjusting for preintervention levels and for clustering within participating sites RR/MD/OR/ difference in absolute change (95% CI)
Intervention meetings based on the Breakthrough Series model	Good outcome regarding death or disability (mRS < 3) at 3 months in people with ischaemic stroke admitted within 4 h of symptom onset	Dirks 2011	cluster randomised trial	6%	58%	RR 0.56 (0.42 to 0.74)
	Mortality at 3 months			0%	17%	RR 1.05 (0.74 to 1.48)
	Quality of life (EuroQoL) at 3 months in participants with ischaemic stroke admitted within 4 h of symptom onset (mean)			−0.02	0.58	MD 0.01 (−0.05 to 0.08)
Multifaceted implementation package	Proportion of participants treated with thrombolysis experiencing favourable 3-month outcomes (mRS 0 to 1), data provided by authors (%)	Levi 2020	cluster randomised trial	4.52%	22.15%	
	Proportion of people treated with thrombolysis experiencing poor 3-month clinical outcomes (mRS 5 to 6) post hoc analysis (%)			1%	14%	OR 1.44 (0.61 to 3.41)
	Proportion of participants treated with thrombolysis experiencing excellent 3-month outcomes (mRS 0 to 2) post hoc analysis (%)			6%	36%	OR 1.33 (0.73 to 2.44)
	Proportion of people treated with thrombolysis experiencing symptomatic intracranial haemorrhage, data provided by authors (%)			−1.63%	2.99%	OR 0.52 (0.09 to 2.93)
	Proportion of people treated with thrombolysis experiencing parenchymal haematoma post hoc analysis			1.5%	6%	OR 0.96 (0.36 to 2.52)
Treatment protocols to manage fever, hyperglycaemia and	Death or dependency (mRS ≥ 2) at 90 d postadmission (%)	Middleton 2011	cluster randomised trial	−15.4%	57.7%	Difference in absolute change 15.7% (5.8 to 25.4)

Table 15. Comparison 2. Patient outcomes *(Continued)*

swallowing dysfunction with multi-disciplinary team building workshops to address implementation barriers						
	Mortality at 90 d postadmission (%)			−1%	5%	No significant effect (P = 0.30), data not presented
	Functional dependency (Barthel index) ≥ 95 at 90 d (%)			9.0%	60.0%	Difference in absolute change 9.5% (−0.5 to 19.5)
	Functional dependency (Barthel index) ≥ 60 at 90 d (%)			1.7%	89.8%	Difference in absolute change 2.5% (−3.6 to 8.6)
	Quality of life: mean SF-36 mental component summary score at 90 d			−0.1	49.4	Difference in absolute change 0.5 (−1.9 to 2.8)
	Quality of life: mean SF-36 physical component summary score at 90 d			3.1	42.5	Difference in absolute change 3.4 (1.2 to 5.5)
	Mean temperature for the first 72 h after stroke unit admission (degrees, Celsius)			−0.1	36.6	Difference in absolute change 0.09 (0.04 to 0.15)
	Mean finger-prick blood glucose for the first 72 h after stroke unit admission (mmol/L)			−0.2	7.0	Difference in absolute change 0.54 (0.08 to 1.01)
	Discharge diagnosis of aspiration pneumonia (%)			−0.5%	2.7%	No significant effect, data not presented
	Mortality at 1 to 4 years (not named outcome of interest in main paper) (%)			5%	27.3%	RR 0.77 (0.59 to 0.99)
Evidence-based clinical pathway, written care protocols for im-		Wang 2018	cluster randomised trial	Stroke-unit-only data not available		

Table 15. Comparison 2. Patient outcomes *(Continued)*

plementation of performance measures, a full-time quality coordinator and a monitoring and feedback system. Training in quality improvement methods.					
	In-hospital death		Stroke-unit-only data not available		
	Mortality at 3 months		Stroke-unit-only data not available		
	Mortality at 6 months		Stroke-unit-only data not available		
	Mortality at 12 months (%)		−0.9%	6.2%	Data not presented
	New clinical vascular event (ischaemic stroke, haemorrhagic stroke, myocardial infarction, or vascular death) at 12 months (%)		−2.2%	10.9%	Data not presented
	Disability as measured by mRS of 3 to 5 at 12 months (%)		−2.0%	13.8%	Data not presented

Abbreviations: CI: confidence interval; EuroQoL: European Quality of Life Scale; MD: mean difference; OR: odds ratio; RR: risk ratio; SF-36: 36-item Short Form Survey

Table 16. Comparison 2. Utilisation, coverage or access outcomes

Intervention	Outcome	Study	Type of study	Absolute postintervention difference	Postintervention level in control group	Effect after adjusting for preintervention levels and for clustering within participating sites. MD (95% CI)
Treatment protocols to manage fever, hyperglycaemia and swallowing dysfunction with multidisciplinary team building work-	Length of hospital stay (d)	Middleton 2011	cluster randomised trial	−2.4	13.7	MD 1.5 (−0.5 to 3.5)

Table 16. Comparison 2. Utilisation, coverage or access outcomes *(Continued)*

shops to address implementation barriers				

Abbreviations: CI: confidence interval; MD: mean difference

Table 17. Comparison 2. Health professional knowledge, attitudes, intentions

Intervention	Outcome	Study	Type of study	Absolute postintervention difference (MD)	Absolute preintervention difference (MD)	Postintervention level in control group (MD)	Relative effect MD (95% CI)
Multifaceted implementation package	Staff perception of hospital performance indicators, feedback and training (score on 74-item researcher-developed survey using 5-point Likert scale, higher is better)	Levi 2020	cluster randomised trial	0.15	−0.08	3.02	MD 0.21 (0.09 to 0.34)
	Staff perception about the evidence base for intravenous thrombolysis and its implementation (score on 74-item researcher-developed survey using 5-point Likert scale, higher is better)			0.15	−0.06	3.14	MD 0.21 (0.06 to 0.36)
	Staff perception about personal stroke skills and hospital stroke care policies (score on 74-item researcher-developed survey using 5-point Likert scale, higher is better)			0.05	0	3.55	MD 0.04 (−0.10 to 0.18)
	Staff perceptions toward emergency service (score on 74-item researcher-developed survey using 5-point Likert scale, higher is better)			0.04	−0.07	3.36	MD 0.10 (−0.07 to 0.27)

Abbreviations: CI: confidence interval; MD: mean difference

Table 18. Comparison 4. Uptake or increase in patient-centred goal setting[a]

Intervention	Outcome	Study	Postintervention level in goal setting group	Postintervention total participants	Postintervention level in information provision group	Total participants	OR
Interactive education session and workshop, interactive PDF information package, written protocols (reanalysed)	Collaborative goal setting	Shrubsole 2018	5	25	0	36	OR 2.38 (95% CI 0.82 to 6.89)

[a]Data reanalysed to compare one group to another
Abbreviations: CI: confidence interval; OR: odds ratio

Table 19. Comparison 4. Uptake or increase in assessments for post-acute rehabilitation[a]

Intervention	Outcome	Study	Type of study	Absolute postintervention difference (%)	Absolute preintervention difference (%)	Postintervention level in control group	Effect after adjusting for preintervention levels and for clustering within participating sites. OR (95% CI)
Education only vs education, audit and feedback, barrier identification and strategy development workshop, opinion leader, reminders	Assessment of rehabilitation needs	Lynch 2016	cluster randomised trial	3%	−3%	74%	1.29 (95% CI 0.63 to 2.67)

[a]72% participants were treated in acute stroke units
Abbreviations: CI: confidence interval; OR: odds ratio

Table 20. Comparison 4. Uptake or increase in information provision[a]

Intervention	**Outcome**	**Study**	**Postintervention level in information provision**	**Total participants in postintervention**	**Postintervention level in goal setting**	Total participants	**OR**
Interactive education session and workshop, interactive PDF information package, written protocols	Information provision	Shrubsole 2018	19	36	8	25	OR 0.05 (95% CI 0.00 to 0.97) unit of analysis error

[a]Group receiving goal setting intervention treated as 'intervention' group, group receiving information intervention treated as comparator group
Abbreviations: CI: confidence interval; OR: odds ratio

Table 21. Comparison 4. Health professional knowledge, attitudes, intentions

Intervention	Outcome	Study	Number of participants	Mean difference[a] (95% CI)
Information provision compared to goal setting (data provided by authors, unit of analysis error)	Knowledge about information provision (survey scores, 68-item survey developed by authors, used 5-point Likert scale)	Shrubsole 2018	64	0.00 (−0.53 to 0.52)
	Attitude about information provision (survey scores, 68-item survey developed by authors, used 5-point Likert scale)	Shrubsole 2018	64	−0.20 (−0.72 to 0.32)
	Intention about information provision (survey scores, 68-item survey developed by authors, used 5-point Likert scale)	Shrubsole 2018	64	−0.04 (−0.39 to 0.31)
Goal setting compared to information provision (data provided by authors, unit of analysis error)	Knowledge about goal setting (survey scores, 68-item survey developed by authors, used 5-point Likert scale)	Shrubsole 2018	64	0.31 (0.09 to 0.54)
	Attitude about goal setting (survey scores, 68-item survey developed by authors, used 5-point Likert scale)	Shrubsole 2018	64	0.00 (−0.57 to 0.57)
	Intention about goal setting (survey scores, 68-item survey developed by authors, used 5-point Likert scale)	Shrubsole 2018	64	0.04 (−0.27 to 0.35)

[a]Postintervention mean difference
Abbreviations: CI: confidence interval

APPENDICES

Appendix 1. Search Strategy

Search Strategy	
MEDLINE (OVID) Search String	
1	cerebrovascular disorders/ or exp basal ganglia cerebrovascular disease/ or exp brain ischemia/ or exp carotid artery diseases/ or exp cerebrovascular trauma/ or exp intracranial arterial diseases/ or exp intracranial arteriovenous malformations/ or exp intracranial embolism/ or exp intracranial thrombosis/ or exp intracranial hemorrhages/ or stroke/ or exp brain infarction/ or vasospasm, intracranial/ or vertebral artery dissection/
2	(stroke or cerebrovasc* or brain vasc* or cerebral vasc* or cva* or apoplex*).mp.
3	((brain* or cerebr* or cerebell* or vertebrobasilar or hemispher* or intracran* or intracerebral or infratentorial or supratentorial or mca or anterior circulation or posterior circulation or basal ganglia) adj5 (isch?emi* or infarct* or thrombo* or emboli*)).mp.

(Continued)

4	((brain* or cerebr* or cerebell* or intracerebral or intracran* or parenchymal or intraventricular or infratentorial or supratentorial or basal gangli*) adj5 (haemorrhage* or hemorrhage* or haematoma* or hematoma* or bleed*)).mp.
5	1 or 2 or 3 or 4
6	hospital units/ or patient care team/
7	(stroke adj3 (unit* or ward* or hospital* or centre* or center* or team*)).mp.
8	((organi?ed or structured) adj3 care).mp.
9	(rehabilitation adj3 (unit* or ward* or hospital* or centre* or center* or team*)).mp.
10	(multidisciplinary adj3 (unit* or ward* or hospital* or centre* or center* or team*)).mp.
11	((dedicated or discrete or comprehensive) adj5 (unit* or ward* or hospital* or centre* or center* or team*)).mp.
12	((specialist or speciali?ed) adj5 (nurs* or staff* or care or unit* or ward*)).mp.
13	(organi?ed adj3 (unit* or ward*)).mp.
14	6 or 7 or 8 or 9 or 10 or 11 or 12 or 13
15	5 and 14
16	practice guidelines/ or practice guidelines as a topic/ or clinical protocols/
17	exp education, continuing/ or exp education, nursing/ or exp education, medical/
18	inservice training/ or competency-based education/
19	((educat* or inform*) adj2 (program* or interven* or meet* or session* or strateg* or workshop* or visit*)).mp.
20	teaching materials/
21	((leaflet? or booklet? or poster? or writ* or print*) adj3 (inform* or educat*)).mp.
22	guideline?.mp.
23	16 or 17 or 18 or 19 or 20 or 21 or 22
24	mentors/
25	leadership/
26	((opinion or educat* or influen*) adj1 leader*).mp.
27	24 or 25 or 26
28	Patient-Centered Care/
29	((patient* or client* or survivor*) adj2 (mediat* or direct*)).mp.

(Continued)

30	28 or 29
31	clinical audit/ or medical audit/ or nursing audit/
32	benchmarking/
33	guideline adherence/ or quality indicators, healthcare/
34	process assessment health care/
35	physician practice patterns/ or nurses practice patterns/
36	((audit* or process assess* or benchmark*) adj3 feedback).mp.
37	31 or 32 or 33 or 34 or 35 or 36
38	reminder systems/
39	(remind* or prompt*).mp.
40	38 or 39
41	total quality management/ or quality improvement/
42	exp evidence based practice/
43	quality of healthcare/
44	communication barriers/
45	((barrier* or facilitat*) adj3 (best or recommend* or evidence)).mp.
46	((individual* or tailor*) adj3 (best or recommend* or evidence or implement*)).mp.
47	41 or 42 or 43 or 44 or 45 or 46
48	mass media/ or telecommunications/
49	marketing/ or information dissemination/
50	Audiovisual Aids/
51	48 or 49 or 50
52	health services research/
53	((action or participat*) adj1 research*).mp.
54	52 or 53
55	health knowledge, attitudes, practice/ or attitude of health personnel/
56	((attitude* or knowledge) adj3 (staff or clinic* or profession* or nurs* or physiotherapy* or physical therap* or ot or occupational therap* or pharmac* or speech therap* or speech pathology* or speech*language path* or doctor* or physician* or neurologist* or nutritionist* or dietician* or dietetic* or social worker*)).mp.

(Continued)

57	55 or 56
58	23 or 27 or 30 or 37 or 40 or 47 or 51 or 54 or 57
59	health services administration/ or "organization and administration"/ or hospital administration/ or health facility administration/
60	centralized hospital services/ or hospital restructuring/ or hospital shared services/
61	health planning organizations/ or health care coalitions/ or health planning councils/ or "state health planning and development agencies"/
62	health policy/ or health care reform/
63	clinical governance/ or "constitution and bylaws"/ or decision making, organizational/ or efficiency, organizational/
64	governing board/ or trustees/ or institutional management teams/
65	management audit/ or benchmarking/ or models, organizational/
66	organizational culture/ or organizational innovation/ or organizational objectives/
67	capacity building/ or program development/
68	diffusion of innovation/ or knowledge management/
69	technology transfer/ or translational research/
70	og.fs.
71	organi?ational.ti,ab.
72	organi?ation*.hw.
73	(organi?ation* adj3 (change or changes or changing or collaborat* or development or impact or influenc* or infrastructure? or interprofession* or inter-profession* or intervention? or multicomponent or multi-component or multidisciplin* or multidisciplin* or multifacet* or multi-facet* or multimodal* or multi-modal* or policy or policies or strategy or strategies or strategic or structur* or support* or system?)).ti,ab.
74	policy.hw.
75	(policy or policies or (nurse adj4 managed) or (quality adj2 improvment) or (qi adj2 (initiative? or program* or hospital*))).ti,ab.
76	(decentral* or empower* or governance or jurisdiction? or roster* or stewardship? or structural or team* or ((change? or changing) adj2 (direct* or initiat* or role or roles))).ti,ab.
77	(administrative or administrator?).ti.
78	((administrative or administrator?) adj4 (change or changes or changing or collaborat* or development or impact or influenc* or infrastructure? or interprofession* or interprofession* or intervention? or multicomponent or multi-component or multidisciplin* or multi-disciplin* or multifacet* or multi-facet* or multimodal* or multi-modal* or policy or policies or strategy or strategies or strategic or structur* or support* or system?)).ab.

(Continued)

79	(governance or jurisdiction? or roster* or team* or structural or organizational or selfdirect* or (nurse adj2 (direct* or initiat*))).ti,ab.
80	(stewardship or decentral* or reform? or reforming).ti,ab.
81	59 or 60 or 61 or 62 or 63 or 64 or 65 or 66 or 67 or 68 or 69 or 70 or 71 or 72 or 73 or 74 or 75 or 76 or 77 or 78 or 79 or 80
82	career mobility/ or employee incentive plans/ or job description/ or personnel administration, hospital/ or personnel delegation/ or "personnel staffing and scheduling"/ or staff development/ or workload/ or workplace/
83	professional autonomy/ or professional role/
84	((professional* or clinician*) adj2 (autonomy or independence or self-reliance)).ti,ab.
85	(professional adj2 development).ti,ab.
86	((advance* or scope) adj3 practice*).ti,ab.
87	82 or 83 or 84 or 85 or 86
88	critical pathway/
89	(clinical protocol or treatment planning).ti,ab.
90	((clinical or critical or care) adj1 (path or paths or pathway?)).ti,ab.
91	(care adj (map or maps or plan*)).ti,ab.
92	stroke program*.ti,ab.
93	(case management or case manager?).ti,ab.
94	case management/
95	88 or 89 or 90 or 91 or 92 or 93 or 94
96	58 or 81 or 87 or 95
97	randomized controlled trial.pt.
98	Randomized Controlled Trials as Topic
99	controlled clinical trial.pt.
100	(randomis* or randomiz* or randomly or trial or multicenter or multicentre or multi centre).ti,ab.
101	97 or 98 or 99 or 100
102	review.pt.
103	meta analysis.pt.
104	news.pt.

(Continued)

105	comment.pt.
106	editorial.pt.
107	cochrane database of systematic reviews.jn.
108	comment on.cm.
109	(systematic review or literature review).ti.
110	102 or 103 or 104 or 105 or 106 or 107 or 108 or 109
111	101 not 110
112	15 and 96 and 111
Cochrane Central Register of Controlled Trials (Cochrane Library, Wiley)	
#1	[mh "cerebrovascular disorders"] or [mh "basal ganglia cerebrovascular disease"] or [mh "brain ischemia"] or [mh "carotid artery diseases"] or [mh "cerebrovascular trauma"] or [mh "intracranial arterial diseases"] or [mh "intracranial arteriovenous malformations"] or [mh "intracranial embolism"] or [mh "intracranial thrombosis"] or [mh "intracranial hemorrhages"] or [mh stroke] or [mh "brain infarction"] or [mh "vasospasm, intracranial"] or [mh "vertebral artery dissection"]
#2	(stroke or cerebrovasc* or brain next vasc* or cerebral next vasc* or cva* or apoplex*):ti,ab
#3	((brain* or cerebr* or cerebell* or vertebrobasilar or hemispher* or intracran* or intracerebral or infratentorial or supratentorial or mca or anterior next circulation or posterior next circulation or basal next ganglia) near/5 (ischemi* or ischaemi* or infarct* or thrombo* or emboli*)):ti,ab
#4	((brain* or cerebr* or cerebell* or intracerebral or intracran* or parenchymal or intraventricular or infratentorial or supratentorial or basal next gangli*) near/5 (haemorrhage* or hemorrhage* or haematoma* or hematoma* or bleed*)):ti,ab
#5	{or #1-#4}
#6	[mh "hospital units"] or [mh "patient care team"]
#7	(stroke near/3 (unit* or ward* or hospital* or centre* or center* or team*)):ti,ab
#8	((organi* or structured) near/3 care):ti,ab
#9	(rehabilitation near/3 (unit* or ward* or hospital* or centre* or center* or team*)):ti,ab
#10	(multidisciplinary near/3 (unit* or ward* or hospital* or centre* or center* or team*)):ti,ab
#11	((dedicated or discrete or comprehensive) near/5 (unit* or ward* or hospital* or centre* or center* or team*)):ti,ab
#12	((specialist or speciali*) near/5 (nurs* or staff* or care or unit* or ward*)):ti,ab
#13	(organi* near/3 (unit* or ward*)):ti,ab
#14	{or #6-#13}
#15	#5 and #14

(Continued)

Embase (OVID)

No.	Search terms
1	exp *cerebrovascular accident/ or *cerebrovascular disease/ or exp *brain ischemia/ or exp *brain infarction/ or *subarachnoid hemorrhage/ or exp *brain haemorrhage/ or *stroke patient/
2	(stroke or cerebrovasc* or brain vasc* or cerebral vasc* or cva* or apoplex*).mp.
3	((brain* or cerebr* or cerebell* or vertebrobasilar or hemispher* or intracran* or intracerebral or infratentorial or supratentorial or mca or anterior circulation or posterior circulation or basal ganglia) adj5 (isch?emi* or infarct* or thrombo* or emboli*)).mp.
4	((brain* or cerebr* or cerebell* or intracerebral or intracran* or parenchymal or intraventricular or infratentorial or supratentorial or basal gangli*) adj5 (haemorrhage* or hemorrhage* or haematoma* or hematoma* or bleed*)).mp.
5	or/1-4
6	*"hospital subdivisions and components"/ or *hospital department/ or *stroke unit/
7	(stroke adj3 (unit* or ward* or hospital* or centre* or center* or team*)).mp.
8	((organi?ed or structured) adj3 care).mp.
9	(rehabilitation adj3 (unit* or ward* or hospital* or centre* or center* or team*)).mp.
10	(multidisciplinary adj3 (unit* or ward* or hospital* or centre* or center* or team*)).mp.
11	((dedicated or discrete or comprehensive) adj5 (unit* or ward* or hospital* or centre* or center* or team*)).mp.
12	((specialist or speciali?ed) adj5 (nurs* or staff* or care or unit* or ward*)).mp.
13	(organi?ed adj3 (unit* or ward*)).mp.
14	or/6-13
15	5 and 14
16	*practice guideline/ or *clinical protocol/
17	guideline?.mp.
18	exp *nursing education/ or exp *medical education/
19	*in service training/
20	((educat* or inform*) adj2 (program* or interven* or meet* or session* or strateg* or workshop* or visit*)).mp.
21	*continuing education/
22	((leaflet? or booklet? or poster? or writ* or print*) adj3 (inform* or educat*)).mp.
23	or/16-22

(Continued)

24	*mentor/
25	*leadership/
26	((opinion or educat* or influen*) adj1 leader*).mp.
27	or/24-26
28	((patient* or client* or survivor*) adj2 (mediat* or direct*)).mp.
29	*clinical audit/ or *nursing audit/
30	*benchmarking/
31	*health care quality/
32	practice pattern?.mp.
33	((audit* or process assess* or benchmark*) adj3 feedback).mp.
34	or/28-33
35	*reminder system/
36	(remind* or prompt*).mp.
37	or/35-36
38	*total quality management/
39	exp *evidence based practice/
40	((barrier* or facilitat*) adj3 (best or recommend* or evidence)).mp.
41	((individual* or tailor*) adj3 (best or recommend* or evidence or implement*)).mp.
42	or/38-41
43	exp *mass communication/
44	*information dissemination/
45	*audiovisual aid/
46	or/43-45
47	*health services research/
48	((action or participat*) adj1 research*).mp.
49	or/47-48
50	*attitude to health/
51	exp *health personnel attitude/

(Continued)

52	((attitude* or knowledge) adj3 (staff or clinic* or profession* or nurs* or physiotherapy* or physical therap* or ot or occupational therap* or pharmac* or speech therap* or speech pathology* or speech*language path* or doctor* or physician* or neurologist* or nutritionist* or dietician* or dietetic* or social worker*)).mp.
53	or/50-52
54	23 or 27 or 34 or 37 or 42 or 46 or 49 or 53
55	*"organization and management"/ or *hospital management/
56	*hospital organization/ or exp *health care organization/
57	*health care planning/
58	*health care policy/
59	*board of trustees/
60	*capacity building/ or *program development/
61	*knowledge management/
62	*translational research/
63	organi?ational.ti,ab.
64	organi?ation*.hw.
65	(organi?ation* adj3 (change or changes or changing or collaborat* or development or impact or influenc* or infrastructure? or interprofession* or inter-profession* or intervention? or multicomponent or multi-component or multidisciplin* or multi-disciplin* or multifacet* or multi-facet* or multimodal* or multi-modal* or policy or policies or strategy or strategies or strategic or structur* or support* or system?)).ti,ab.
66	policy.hw.
67	(policy or policies or (nurse adj4 managed) or (quality adj2 improvment) or (qi adj2 (initiative? or program* or hospital*))).ti,ab.
68	(decentral* or empower* or governance or jurisdiction? or roster* or stewardship? or structural or team* or ((change? or changing) adj2 (direct* or initiat* or role or roles))).ti,ab.
69	(administrative or administrator?).ti.
70	((administrative or administrator?) adj4 (change or changes or changing or collaborat* or development or impact or influenc* or infrastructure? or interprofession* or inter-profession* or intervention? or multicomponent or multi-component or multidisciplin* or multi-disciplin* or multifacet* or multi-facet* or multimodal* or multi-modal* or policy or policies or strategy or strategies or strategic or structur* or support* or system?)).ab.
71	(governance or jurisdiction? or roster* or team* or structural or organizational or self-direct* or (nurse adj2 (direct* or initiat*))).ti,ab.
72	(stewardship or decentral* or reform? or reforming).ti,ab.
73	or/55-72

(Continued)

74	*career mobility/ or *personnel management/
75	*professional standard/
76	((professional* or clinician*) adj2 (autonomy or independence or self-reliance)).ti,ab.
77	(professional adj2 development).ti,ab.
78	((advance* or scope) adj3 practice*).ti,ab.
79	or/74-78
80	((clinical or critical or care) adj1 (path or paths or pathway?)).ti,ab.
81	(clinical protocol or treatment planning).ti,ab.
82	(care adj (map or maps or plan*)).ti,ab.
83	stroke program*.ti,ab.
84	(case management or case manager?).ti,ab.
85	*clinical pathway/
86	*case management/
87	or/80-86
88	54 or 73 or 79 or 87
89	15 and 88
90	randomized controlled trial/
91	controlled clinical trial/
92	quasi experimental study/
93	pretest posttest control group design/
94	time series analysis/
95	experimental design/
96	multicenter study/
97	(randomis* or randomiz* or randomly).ti,ab.
98	groups.ab.
99	(trial or multicentre or multicenter or multi centre or multi center).ti.
100	(intervention? or effect? or impact? or controlled or control group? or (before adj5 after) or (pre adj5 post) or ((pretest or pre test) and (posttest or post test)) or quasiexperiment* or quasi experiment* or pseudo experiment* or pseudoexperiment* or evaluat* or time series or time point? or repeated measur*).ti,ab.

(Continued)

101	or/90-100
102	(systematic review or literature review).ti.
103	"cochrane database of systematic reviews".jn.
104	exp animals/ or exp invertebrate/ or animal experiment/ or animal model/ or animal tissue/ or animal cell/ or nonhuman/
105	human/ or normal human/ or human cell/
106	104 not (104 and 105)
107	102 or 103 or 106
108	101 not 107
109	89 and 108

CINAHL (EBSCO)

No.	**Search terms**
S1	(MH "Stroke+") OR (MH "Cerebrovascular Disorders+") OR (MH "Cerebral Ischemia+") OR (MH "Intracranial Hemorrhage+") OR (MH "Subarachnoid Hemorrhage")
S2	(stroke or cerebrovasc* or brain vasc* or cerebral vasc* or cva* or apoplex*)
S3	((brain* or cerebr* or cerebell* or vertebrobasilar or hemispher* or intracran* or intracerebral or infratentorial or supratentorial or mca or anterior circulation or posterior circulation or basal ganglia) N5 (isch?emi* or infarct* or thrombo* or emboli*))
S4	((brain* or cerebr* or cerebell* or intracerebral or intracran* or parenchymal or intraventricular or infratentorial or supratentorial or basal gangli*) N5 (haemorrhage* or hemorrhage* or haematoma* or hematoma* or bleed*))
S5	S1 OR S2 OR S3 OR S4
S6	(stroke N3 (unit* or ward* or hospital* or centre* or center* or team*))
S7	((organi?ed or structured) N3 care)
S8	(rehabilitation N3 (unit* or ward* or hospital* or centre* or center* or team*))
S9	(multidisciplinary N3 (unit* or ward* or hospital* or centre* or center* or team*))
S10	((dedicated or discrete or comprehensive) N5 (unit* or ward* or hospital* or centre* or center* or team*))
S11	((specialist or speciali?ed) N5 (nurs* or staff* or care or unit* or ward*))
S12	(organi?ed N3 (unit* or ward*))
S13	(MH "Hospital Units+")
S14	(MH "Multidisciplinary Care Team+")

(Continued)

S15	S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14
S16	S5 AND S15
S17	PT randomized controlled trial
S18	PT clinical trial
S19	PT research
S20	(MH "Randomized Controlled Trials")
S21	(MH "Clinical Trials")
S22	(MH "Multicenter Studies")
S23	(MH "Health Services Research")
S24	TI (randomis* or randomiz* or randomly) OR AB (randomis* or randomiz* or randomly)
S25	TI (trial or effect* or impact* or intervention* or before N5 after or pre N5 post or ((pretest or "pre test") and (posttest or "post test")) or quasiexperiment* or quasi W0 experiment* or pseudo experiment* or pseudoexperiment* or evaluat* or "time series" or time W0 point* or repeated W0 measur*) OR AB (trial or effect* or impact* or intervention* or before N5 after or pre N5 post or ((pretest or "pre test") and (posttest or "post test")) or quasiexperiment* or quasi W0 experiment* or pseudo experiment* or pseudoexperiment* or evaluat* or "time series" or time W0 point* or repeated W0 measur*)
S26	S17 OR S18 OR S19 OR S20 OR S21 OR S22 OR S23 OR S24 OR S25 OR S26 OR S27 OR S28 OR S29 OR S30
S27	S16 AND S31
ProQuest Dissertations & Theses Global	
S1	TI,AB(stroke OR cerebrovasc* OR brain vasc* OR cerebral vasc* OR cva* OR apoplex*)
S2	TI,AB (stroke unit* OR stroke ward* OR stroke hospital* OR stroke centre* OR stroke center* OR stroke team* OR organi?ed care OR structured care OR rehabilitation unit* OR rehabilitation ward* OR rehabilitation hospital* OR rehabilitation centre* OR rehabilitation center* OR rehabilitation team* OR multidisciplinary unit* OR multidisciplinary ward* OR multidisciplinary hospital* OR multidisciplinary centre* OR multidisciplinary center* OR multidisciplinary team* OR dedicated unit* OR discrete unit* OR dedicated ward* OR discrete ward* OR dedicated hospital* OR discrete hospital* OR dedicated centre* OR discrete centre* OR dedicated center* OR discrete center* OR dedicated team* OR discrete team* OR comprehensive unit* OR comprehensive ward* OR comprehensive hospital* OR comprehensive centre* OR comprehensive center* OR comprehensive team* OR speciali* nurs* OR speciali* staff* OR speciali* care OR speciali* unit* OR speciali* ward* OR organi* unit* OR organi* ward*)
S3	SU(health*) OR TI(effect OR effects OR impact OR influenc* OR random* OR study OR controlled OR trial OR effectiveness) OR ALL(random* OR intervention OR collaborat* OR team* OR multidisciplin* OR multi-disciplin* OR crossdisciplin* OR cross-disciplin* OR interdisciplin* OR community OR quasi*) OR ALL(before NEAR/10 after) OR ALL(before NEAR/10 during) OR ALL("time series" OR timeseries) OR ALL((control* NEAR/2 group) OR (control NEAR/2 study) OR (control NEAR/2 cohort))
S4	S1 AND S2 AND S3

(Continued)

ClinicalTrials.gov	
1	stroke
2	implement OR implementation OR evidence OR knowledge OR complex
3	Interventional studies
WHO International Clinical Trials Registry Platform (ICTRP)	
1	stroke AND implement*
2	stroke AND evidence*
3	stroke AND knowledge*
4	stroke AND complex*

Appendix 2. GRADE Profiles

No of studies	Design	Risk of bias	Inconsistency	Indirectness[1]	Imprecision	Other[2]	Certainty (overall score)[3]
QUALITY OF CARE OUTCOMES							
Outcome: Quality of care overview (adherence with evidence-based recommendations)							
4	cluster randomised trial	serious	serious	not serious	serious	not serious	**Very low -** Downgraded 3 levels due to serious risk of bias (high risk of detection bias in 2 studies), inconsistency (high, unexplained heterogeneity), imprecision (wide 95% confidence intervals)
Outcome:Recommended diagnostic procedures							
0	NA	NA	NA	NA	NA	NA	NA
Outcome: Acute medical interventions: proportion of people with ischaemic stroke who received thrombolysis							
2	cluster randomised trial	serious	not serious	not serious	not serious	not serious	**Moderate-** Downgraded 1 level due to risk of bias (high risk of detection bias in 1 study)
Outcome: Acute medical interventions: proportion of patients with ischaemic stroke admitted within 4 hours of stroke who received thrombolysis							
1	cluster randomised trial	not serious	not serious	not serious	not serious	not serious	**Moderate -** downgraded 1 level due to imprecision (only 1 trial)
Outcome: Acute medical interventions: door to needle time							
2	cluster randomised trial	Serious	not serious	not serious	not serious	not serious	**Moderate–** downgraded 1 level due to risk of bias (high

(Continued)

							risk of detection bias and post-hoc analysis in 1 study)
Outcome: Acute medical interventions: proportion of patients who received thrombolysis within 60 minutes of hospital arrival							
1	cluster randomised trial	serious	not serious	not serious	serious	not serious	**Very low** – downgraded 3 levels due to very serious risk of bias (high risk of detection bias and post-hoc analysis in the only included study) and imprecision (only 1 trial)
Outcome: interventions to prevent complications: swallow screen							
1	cluster randomised trial	not serious	not serious	not serious	serious	not serious	**Moderate** - downgraded 1 level due to imprecision (only 1 trial)
Outcome:Interventions to prevent complications: swallow: proportion of patients who received all swallow care elements							
1	cluster randomised trial	not serious	not serious	not serious	serious	not serious	**Moderate** - downgraded 1 level due to imprecision (only 1 trial, wide confidence intervals)
Outcome: referred to speech pathologist if failed swallow screen							
1	cluster randomised trial	not serious	not serious	not serious	serious	not serious	**Moderate** - downgraded 1 level due to imprecision (only 1 trial, wide confidence intervals)
Outcome: interventions to prevent complications: blood glucose: proportion of patients meeting all blood glucose elements							
1	cluster randomised trial	not serious	not serious	not serious	serious	not serious	**Moderate**– downgraded 1 level due to imprecision (only 1 trial)
Outcome: interventions to prevent complications: blood glucose: venous BGL measure on admission to hospital							
1	cluster randomised trial	not serious	not serious	not serious	serious	not serious	**Moderate** – downgraded 1 level due to imprecision (only 1 trial, wide confidence intervals)

(Continued)

Outcome: interventions to prevent complications: blood glucose: finger-prick BGL on admission to stroke unit							
1	cluster randomised trial	not serious	not serious	not serious	serious	not serious	**Moderate -** downgraded 1 level due to imprecision (only 1 trial, wide confidence intervals)
Outcome: interventions to prevent complications: blood glucose: finger-prick BGL every 1-6 hours for first 72 hours							
1	cluster randomised trial	not serious	not serious	not serious	serious	not serious	**Moderate** – downgraded 1 level due to imprecision (only 1 trial)
Outcome: interventions to prevent complications: blood glucose: saline infusion if BGL 8-11mmol/L (if patient diabetic) or 8-16 mmol/L (if patient not diabetic)							
1	cluster randomised trial	not serious	not serious	not serious	serious	not serious	**Moderate** – downgraded 1 level due to imprecision (only 1 trial)
Outcome: interventions to prevent complications: blood glucose: insulin infusion if BGL >11mmol/L (if patient diabetic) or >16 mmol/L (if patient not diabetic)							
1	cluster randomised trial	not serious	not serious	not serious	serious	not serious	**Moderate -** downgraded 1 level due to imprecision (only 1 trial)
Outcome: Interventions to prevent complications: fever care: proportion of patients meeting all fever care elements							
1	cluster randomised trial	not serious	not serious	not serious	serious	not serious	**Moderate** - downgraded 1 level due to imprecision (only 1 trial)
Outcome: Interventions to prevent complications: fever care: temperature monitored and charted during first 72 hours							
1	cluster randomised trial	not serious	not serious	not serious	serious	not serious	**Moderate** - downgraded 1 level due to imprecision (only 1 trial)
Outcome: Interventions to prevent complications: fever care: patients with temp >37.5 treated with paracetamol							
1	cluster randomised trial	not serious	not serious	not serious	serious	not serious	**Moderate** – downgraded 1 level due to imprecision (only 1 trial, wide confidence intervals)

(Continued)

Outcome: patient-centred goal setting								
0	NA	NA	NA	NA	NA	NA	NA	
Outcome: early rehabilitation interventions								
0	NA	NA	NA	NA	NA	NA	NA	
Outcome: prescribing for secondary prevention								
0	NA	NA	NA	NA	NA	NA	NA	
Outcome: referrals within acute setting or to downstream services								
0	NA	NA	NA	NA	NA	NA	NA	
Outcome: assessments for post-acute rehabilitation								
0	NA	NA	NA	NA	NA	NA	NA	
Outcome: information provision								
0	NA	NA	NA	NA	NA	NA	NA	
Outcome: composite improvement outcomes spanning multiple categories								
1	cluster randomised trial	very serious	not serious	not serious	serious	not serious	**Very low –** downgraded 3 levels given very serious risk of bias (downgraded 2 levels for high risk of detection bias and attrition bias) and imprecision (only 1 trial, wide confidence intervals)	
PATIENT OUTCOMES								
Outcome: patient outcome overview (death, disability or dependency) at 90 days								
3	cluster randomised trial	not serious	not serious	serious	serious	not serious	**moderate** - downgraded 1 level due to indirectness (different cut-off scores used)	

(Continued)

Outcome: patient mortality at 90 days							
2	cluster randomised trial	not serious	not serious	not serious	not serious	not serious	**high**
Outcome: patient mortality at 1-4 years							
2	cluster randomised trial	serious	not serious	not serious	not serious	not serious	**moderate –** downgraded 1 level due to risk of bias (selective outcome reporting: outcome not named in protocol)
Outcome: disability or dependence: good outcome (mRS 0-1) at 90 days							
2	cluster randomised trial	not serious	not serious	not serious	not serious	not serious	**high**
Outcome: disability or dependence: good outcome (mRS 0, 1, 2) at 90 days							
2	cluster randomised trial	not serious	not serious	not serious	not serious	not serious	**moderate** - downgraded 1 level due to risk of bias(selective outcome reporting: post-hoc analysis)
Outcome: disability or dependence: mRS 5-6 at 90 days							
1	cluster randomised trial	serious	not serious	not serious	serious	not serious	**Low -** downgraded 2 levels given risk of bias (post-hoc analysis) and imprecision (only 1 study)
Outcome: disability (mRS 3-5) at 12 months							
1	cluster randomised trial	serious	not serious	not serious	very serious	Data from stroke units provided by authors	**Very low –** downgraded 3 levels due to risk of bias (no adjustment for clustering) and very serious imprecision (downgraded 2 levels due to only 1 trial, 95% CI not presented)

(Continued)

Outcome: functional dependency at 90 days							
1	cluster randomised trial	not serious	not serious	not serious	serious	not serious	**Moderate** – downgraded 1 level given imprecision (only 1 trial, wide 95% CI)
Outcome: quality of life at 3 months							
2	cluster randomised trial	not serious	not serious	serious	serious	not serious	**Low** – downgraded 2 levels because of indirectness (different measures used in the 2 studies) and imprecision (variable results between studies)
Outcome:adverse events (parenchymal haematoma, aspiration pneumonia, new clinical vascular event)							
3	cluster randomised trial	serious	not serious	serious	serious	not serious	**Very low –** downgraded 3 levels due to risk of bias (unit of analysis error), indirectness (different measures between studies, different time frames) and imprecision (variable results)
Outcome: mean temperature for first 72 hours after stroke unit admission							
1	cluster randomised trial	not serious	not serious	not serious	not serious	not serious	**Moderate** – downgraded 1 level given imprecision (only 1 trial)
Outcome: mean finger-prick blood glucose for first 72 hours after stroke unit admission							
1	cluster randomised trial	not serious	not serious	not serious	serious	not serious	**Moderate –** downgraded 1 level given imprecision (only 1 trial)
UTILISATION, COVERAGE OR ACCESS OUTCOMES							
Outcome: length of stay							

(Continued)

1	cluster randomised trial	not serious	not serious	not serious	serious	not serious	**Moderate** – downgraded 1 level given imprecision (only 1 trial)
RESOURCE USE AND ECONOMIC OUTCOMES							
N/A: no studies reported							
HEALTH PROFESSIONAL KNOWLEDGE, ATTITUDES, INTENTIONS							
1	cluster randomised trial	very serious	not serious	serious	serious	not serious	**Very low** – downgraded 3 levels due to very serious risk of bias (low response rate) and imprecision (only 1 trial, not powered for this outcome measure) and indirectness (non-validated survey)
Multifaceted vs multifaceted intervention:							
QUALITY OF CARE OUTCOMES							
Outcome: Uptake or increase in patient-centred goal setting							
1	cluster randomised trial	very serious	not serious	not serious	serious	not serious	**Very low -** downgraded 3 levels due to very serious risk of bias (downgraded 2 levels because baseline characteristics not compared between groups, not powered, clustering not accounted for in analysis) and imprecision (only 1 trial)
Outcome: Uptake or increase in assessments for post-acute rehabilitation							
1	cluster randomised trial	not serious	not serious	not serious	serious	not serious	**Moderate** –downgraded 1 level due to imprecision (only 1 trial)
Outcome: uptake or increase in information provision							

(Continued)

1	cluster randomised trial	very serious	not serious	not serious	serious	not serious	**Very low** - downgraded 3 levels due to very serious risk of bias (downgraded 2 levels because baseline characteristics not compared between groups, unable to account for clustering in analysis) and imprecision (only 1 trial, no power calculation)
HEALTH PROFESSIONAL KNOWLEDGE ATTITUDE, INTENTION							
1	cluster randomised trial	very serious	not serious	not serious	serious	not serious	**Very low** - downgraded 3 levels due to risk of bias (unable to account for clustering in analysis), indirectness (non-validated survey) and imprecision (only 1 trial, not powered for this outcome measure)

[1] Indirectness includes consideration of

- Indirect (between study) comparisons
- Indirect (surrogate) outcomes
- Applicability (study populations, interventions or comparisons that are different than those of interest)

[2] Other considerations for downgrading include publication bias. Other considerations for upgrading include a strong association with no plausible confounders, a dose response relationship, and if all plausible confounders or biases would decrease the size of the effect (if there is evidence of an effect), or increase it if there is evidence of no harmful effect (safety)

[3] 4 **High** = This research provides a very good indication of the likely effect. The likelihood that the effect will be substantially different** is low.

3 **Moderate** = This research provides a good indication of the likely effect. The likelihood that the effect will be substantially different** is moderate.

2 **Low** = This research provides some indication of the likely effect. However, the likelihood that it will be substantially different** is high.

1 **Very low** = This research does not provide a reliable indication of the likely effect. The likelihood that the effect will be substantially different** is very high.

** Substantially different = a large enough difference that it might affect a decision

HISTORY

Protocol first published: Issue 1, 2017

CONTRIBUTIONS OF AUTHORS

EL led the project, and was involved in the selection of studies, quality assessment of studies, data abstraction, data entry and analysis, preparation of text.

HC, JL, KB, HJ, LC, TT, LB assisted in screening and selection of studies

HC, JL, LB, LC assisted in data extraction and quality assessment of studies

HJ, LB assisted in assessment of study complexity and led narrative synthesis of results

KB led preparation of tables to describe each intervention, assisted by HC and LB

TT and EMcI prepared summary of findings table

SM, DC, EMcI contributed to preparation of main text, in particular the Discussion and Conclusion.

DECLARATIONS OF INTEREST

Elizabeth Lynch: lead author of a trial that was included in this review, which was funded by Stroke Foundation and NSW Agency for Clinical Innovation (EL was not involved in study selection, data extraction or analysis of this trial). EL is employed by National Health and Medical Research Council, and an independent contractor for National Stroke Foundation and Singapore Health, but does not receive funds personally, benefit financially from or have access or control of these funds. EL is co-chair of Stroke Foundation Living Guidelines. None of these organisations had any influence on the conduct of this review. EL has also published an opinion in a medical journal on this topic

Julie Luker: co-author of a trial that was included in this review (JL was not involved in study selection, data extraction or analysis of this trial). JL is a health researcher at the University of South Australia, which had no influence on the conduct of this review. Editorial role with the Cochrane Wounds Group, and had no involvement in the editorial process of this review.

Louise Craig: none known.

Heilok Cheng: none known.

Heidi Janssen: none known.

Kathleen Bagot: none known.

Elizabeth McInnes: co-author of a trial that was included in this review, which was funded by National Health and Medical Research Council (EMcI was not involved in study selection, data extraction or analysis of this trial).

Tharshanah Thayabaranathan: none known.

Lemma Bulto: none known.

Sandy Middleton: lead author of a trial that was included in this review, which was funded by National Health and Medical Research Council (SM was not involved in study selection, data extraction or analysis of this trial). SM works as a health professional (Professor of Nursing).

Dominique Cadilhac: co-author of 2 trials that were included in this review, one of which was funded by National Health and Medical Research Council (DC was not involved in study selection, data extraction or analysis of these trials). Recipient of a restricted educational grant from Amgen unrelated to this work; DC is employed by Florey Institute of Neuroscience and Mental Health (funds received by DC personally) and was recipient of grants from Australian Stroke Alliance (payment to institution, DC benefited financially from payment/had access to funds), National Health and Medical Research Council (funds received by DC personally) and National Heart Foundation of Australia (payment to institution, DC benefited financially from payment/had access to funds). None of these organisations had any influence on the conduct of this review.

SOURCES OF SUPPORT

Internal sources

- New Source of support, Australia

  No sources of support to report

External sources

- National Health & Medical Research Council, Australia

  JL and EAL (1138515) were supported by Early Career Research Fellowships

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

Objective

In our protocol, our secondary objectives were to describe any factors that may modify the effect of implementation interventions, determine factors that may influence the uptake of recommendations in acute stroke units and determine if single or multifaceted intervention strategies are more effective in improving uptake of evidence, patient outcomes, system outcomes or professionals' knowledge, attitudes or intentions. On advice from Cochrane editors, we revised the secondary objectives, so they are now to assess factors that may modify the effect of these interventions, and to determine if single or multifaceted strategies are more effective in increasing adherence to evidence-based recommendations by healthcare professionals working in acute stroke unit environments.

Study selection

In our protocol we planned to include randomised trials, cluster-randomised trials, non-randomised trials, controlled before-after studies with at least two intervention sites and two control sites, interrupted time series, and repeat measures studies (where there is a clearly defined point in time when the intervention occurred and at least three data points before and three after the intervention). The search revealed adequate numbers of randomised trials and cluster-randomised trials, so after requesting a change to our protocol with the Cochrane Group editors, we only included randomised trials and cluster-randomised trials in this review.

Outcome variables

We planned to include primary outcomes identified by trial authors. We have also included secondary outcomes when these aligned with our prespecified outcomes of interest, i.e. in instances where patient outcomes were nominated as the primary outcome of the studies, and process outcomes were listed as secondary outcomes.

Extra outcome subheadings were added under Quality of Care outcomes as relevant data were identified - namely composite improvements spanning multiple categories (for example "bundles of care") and information provision.

Measures of treatment effect

When data were available from only one study but not presented as risk ratio (RR) or standardised mean differenc (SMD), we presented the effect estimate reported by the study authors.

Unit of analysis issues

Clustering

For studies where clusters of individuals were randomised (cluster-randomised trials) to intervention groups, but where inference was intended at the level of the individual, we had planned to conduct analysis to account for correlation of observations within clusters

(Brennan 2009). The use of standard statistical methods assumes independence of observations and in clustered studies can result in artificially small P values and overly narrow confidence intervals (CIs) for the effect estimates (Ukoumunne 1999). We had planned to seek assistance from a statistician to re-analyse data in studies where trial authors used inappropriate statistical methods, and in cases where re-analysis was not possible, we planned to report the effect estimate and annotate the phrase 'unit of analysis error'. We did not include any cluster-randomised trials where trial authors used inappropriate statistical methods, so the reanalysis was not required.

Summary of findings table

We included two quality of care measures for key performance indicators in acute stroke settings that we did not report in our protocol. We included the proportion of patients with ischaemic stroke who receive thrombolysis because treatment with thrombolysis leads to reduced disability in eligible patients, yet timely access to thrombolysis has been identified as an ongoing challenge to optimal stroke care. We selected swallow screen because swallow/nutritional assessment is the process of care most commonly used in stroke clinical registries and is associated with lower case fatality.

Data synthesis

We planned to use meta-analytical methods if possible, to pool RRs measuring the effects of the following three comparisons on health professionals' performance.

- Single implementation interventions versus no intervention.
- Multifaceted implementation interventions versus no intervention.
- Multifaceted implementation interventions versus single interventions.

We added a fourth comparison, namely

- Multifaceted implementation interventions versus another implementation intervention

Subgroup analysis

We had planned to investigate if the effect of the comparisons was modified by the type of setting (i.e. acute stroke units with intensive, semi-intensive, or non-intensive models of care and comprehensive stroke units). In conducting this review, it became apparent that most participating sites were set up as acute stroke units with intensive models of care, and this analysis was not deemed to be of benefit and subsequently was not conducted.

Authorship team

The authorship team has changed - Julie Bernhardt and Ian Graham co-authored the protocol but did not co-author the review, instead providing general support and JB read and commented on an initial draft. Kathleen Bagot, Heilok Cheng, Elizabeth McInnes, Heidi Janssen and Lemma Bulto joined the authorship team after the protocol was completed.

INDEX TERMS

Medical Subject Headings (MeSH)

*Brain Ischemia; China; Health Personnel; *Stroke [therapy]

MeSH check words

Humans