The role of stroke nurses in thrombolysis administration in Australia and the United Kingdom : A cross-sectional survey of current practice

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Abstract

Background: The role of stroke nurses in patient selection and administration of recombinant tissue plasminogen activator (rt-PA) for acute ischaemic stroke is evolving.

Objectives: Compare differences in stroke nurses' practices related to rt-PA administration in Australia and the United Kingdom (UK) and to examine whether these differences influence rt-PA treatment rates.

Methods: Cross- sectional, self-administered questionnaire administered to a lead stroke clinician from hospitals known to provide rt-PA for acute ischaemic stroke. Chi-square tests were used to analyse between-country differences in ten pre-specified rt-PA practices. Non-parametric equality of medians test was used to assess within-country differences for likelihood of undertaking practices and association with rt-PA treatment rates. Reporting followed STROBE checklist.

Results: Response rate 68%; [Australia: 74% (n=63/85); UK: 65% (n=93/144)]. There were significant differences between countries for 7/10 practices. UK nurses were more likely to: request CT scan; screen patient for rt-PA suitability; gain informed consent; use telemedicine to assess, diagnose or treat; assist in the decision for rt-PA with Emergency Department physician or neurologist; and undergo training in rt-PA administration. Reported median hospital rt-PA treatment rates were 12% in the UK and 7.8% in Australia: (7.8%). In Australia, there was an association between higher treatment rates and nurses involvement in 5/10 practices; read and interpret CT scans; screen patient for rt-PA suitability; gain informed consent; assess suitability for rt-PA with neurologist/stroke physician; undergo training in rt-PA administration. There was no relationship between UK treatment rates and likelihood of a stroke nurse to undertake any of the ten rt-PA practices.

Conclusion: Stroke nurses' active role in rt-PA administration can improve rt-PA treatment rates. Models of care that broaden stroke nurses' scope of practice to maximise rt-PA treatment rates for ischaemic stroke patients are needed.

Keywords: Nursing Practices; Recombinant tissue plasminogen activator; Stroke; Survey; Thrombolysis

Relevance to Clinical Practice

This study demonstrates that UK and Australian nurses play an important role in thrombolysis practices, however, they are underutilised. Formalising and extending the role of stroke nurses in rt-PA administration could potentially increase thrombolysis rates with clinical benefits for patients.

Introduction

Thrombolysis using recombinant tissue plasminogen activator (rt-PA) is an effective evidence-based treatment for acute ischaemic stroke (Wardlaw et al., 2012). While there have been significant advancements in other treatment modalities for acute ischaemic stroke such as endovascular clot retrieval (Goyal et al., 2015), rt-PA administration remains a fundamental part of stroke treatment. Administration of intravenous rt-PA is time dependent and when administered within four and a half hours of stroke symptom onset there is significant improvement in clinical outcomes (Emberson et al., 2014; Hacke et al., 2008; Saver et al., 2013). Evidence from recent research also shows improved functional outcomes following thrombolysis in patients with favourable perfusion imaging 4.5 - 9 hours after stroke, including those with wake-up stroke (Campbell et al., 2019; Thomalla et al., 2018). Importantly, the sooner rt-PA is given after the onset of stroke symptoms the more likely there is an improvement in patient outcomes (Fonarow et al., 2011; Atte Meretoja et al., 2014; Saver et al., 2013; Summers et al., 2009; The ATLANTIS, 2004).

Overcoming delays in accessing rt-PA treatment is therefore of critical importance. However, difficulties remain with achieving and sustaining optimal numbers of patients receiving rt-PA in many settings (Paul et al., 2016). Recent figures show that the average proportion of stroke patients in Australian hospitals receiving rt-PA treatment regardless of the time of administration was 10% (Stroke Foundation, 2019), while in the United Kingdom (UK) it was 12% (King's College London). However, in other countries in Europe, the proportion of eligible patients treated has been reported to be as high as 40% (Aguiar de Sousa et al., 2018; A. Meretoja et al., 2012) suggesting that ways to achieve this benchmark in Australia and UK require investigation.

Barriers to receiving rt-PA treatment for acute ischaemic stroke are well documented and include delays in stroke symptom recognition in the community resulting in prolonged time to hospital presentation (Hargis et al., 2015), delays in obtaining and interpreting radiology imaging (Kwan,

Hand, & Sandercock, 2004), relatively common use of non-standard eligibility criteria (Craig et al., 2019), availability of appropriately experienced staff to assess eligibility for rt-PA, delays in obtaining consent, availability of stroke specialists to make the final decision to thrombolyse (Ehlers, Groth Jensen, Bech, Andersen, & Kjølby, 2007; Paul et al., 2016); and poor documentation of assessment of rt-PA eligibility (Middleton et al., 2019). Traditionally, medical practitioners have been responsible for thrombolysis treatment (Catangui, 2013) however, working as part of a multi-disciplinary team, nurses have an integral role in all phases of stroke patient care, including activating and facilitating the thrombolysis treatment pathway (Fitzpatrick & Birns, 2004; Middleton S, Alexandrov, & Grimley, 2015; Summers et al., 2009). More specifically, nurses involvement in screening for thrombolysis (Moran, Nakagawa, Asai, & Koenig, 2016), ordering CT scans (Moran et al., 2016) and assisting with decision-making (Moran et al., 2016; The ATLANTIS, 2004) has been shown to reduce treatment delays. Furthermore, appropriately trained nurses can safely and appropriately administer rt-PA to eligible patients (Fitzpatrick & Birns, 2004).

There remains a lack of information about the current widespread role of stroke nurses in rt-PA administration (Elmer Javier Catangui & Clifford John Roberts, 2014). Accordingly, our aim was to understand the extent of UK and Australian stroke nurses' involvement in thrombolysis treatment practices including patient selection, assessment and decision-making. We also aimed to examine differences in practice between the two countries and investigate potential associations between the stroke nurses' role and rt-PA treatment rates within each country.

Method

Eligible hospitals were those known to provide thrombolysis for acute ischaemic stroke in Australia (n=85) and the United Kingdom (n=144). In Australia, eligible hospitals were identified through the 2015 Stroke Foundation Organisational Survey (National Stroke Foundation, 2015). In the UK, hospitals were identified from the Sentinel Stroke National Audit Programme (SSNAP) (King's College

London) – which collect stroke data in England, Wales, and Northern Ireland. The cross-sectional survey, using a self-administered questionnaire, was conducted between 2013 and 2016. Other results from this survey previously have been reported elsewhere (Craig et al., 2019).

Australian participants were stroke unit coordinators or stroke medical or nursing leads based within the stroke service of participating hospitals. In the UK, the study participants were the SSNAP lead contacts of participating hospitals. These participants were considered the most appropriate to give an informed response to the survey as they either had knowledge of the rt-PA process at their respective hospitals or were able to identify an experienced stroke team member who could complete the questionnaire. All methods were carried out in accordance with relevant guidelines and regulations and are reported using the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist (Supplementary File 1) (Von Elm et al., 2007).

Instrument

A questionnaire was developed, informed by a literature review and suggestions by UK and Australian stroke clinicians and researchers identified as experts. The questionnaire was pilot-tested and modified after feedback from a panel of neurologists and stroke nurses.

The questionnaire comprised a total of 30 questions. The first section captured information on the characteristics of the participating hospital and stroke service such as hospital setting (tertiary versus non-tertiary or district hospital), bed number and availability of a thrombolysis protocol (Yes, No, Don’t know) (9 questions). In the second section, participants were asked how likely a stroke nurse in their hospital would be to undertake ten pre-specified thrombolysis-related practices using a 5-point Likert scale (‘highly unlikely’ to ’highly likely’) (10 questions). They were then asked to provide information from their hospital databases about the following stroke services: previous year average door-to-needle time (time from arrival at hospital to rt-PA administration); number of people

admitted with ischaemic stroke per year; and number of rt-PA treatments per year (6 questions). Finally, data on responder demographics were collected, namely work role (grade of nurse), number of years in role, sex, age and highest level of educational qualification (5 questions).

Questionnaire distribution and data collection

Prior to the questionnaire being distributed, a letter (Australia) or email (UK) was sent to notify potential participants of the upcoming survey. Following this, the questionnaire was sent by mail with a participant information letter. Completed questionnaires were returned in pre-addressed postage-paid envelopes, via fax or email. Non-responders were followed-up by email six weeks after the initial questionnaire distribution, and by a phone call at eight weeks. A second copy of the questionnaire was emailed to non-responders at nine weeks. All responses were anonymous and no identifiable information was collected from participants.

Data analysis

All analyses were undertaken specific to the country of practice (Australian or UK). Frequencies for demographic and organisational characteristics were calculated. Between-country comparisons for categorical variables were undertaken using the chi-squared test where appropriate and Fisher's exact test for variables with one or more low cell counts. Between-country comparisons for continuous variables (rt-PA treatment rate and door-to-needle (DTN) time) were undertaken using the Wilcoxon rank-sum test. The responses of *likelihood to undertake practices* were dichotomised to 'likely' (response options 'highly likely' and 'likely' were combined) or 'unlikely' (response options 'highly unlikely' and 'unlikely' were combined). Between-country differences in rt-PA administration practices were analysed using a Chi-square test. Treatment rates were calculated using the number of rt-PA treatments in the one-year period divided by the number of ischaemic stroke admissions in same period, multiplied by 100 and compared by country. The Wilcoxon rank sum test was used to assess within-country differences for the likelihood of stroke nurses undertaking each of the ten

practices and rt-PA treatment rates. Treatment rates for those 'likely' versus unlikely to undertake each of the ten practices were stratified by country. A composite measure was calculated for each country by dichotomising responses between likely ("likely" and "very likely") and not likely and then adding each of the ten practices. A linear regression model was then used to assess the relationship between likelihood of nurse involvement in rt-PA treatment practices and rt-PA treatment rates. Missing data were handled using pairwise deletion. All analyses were undertaken using Stata Statistical Software version 14 or R 3.6.1 (StataCorp, 2015).

Ethical approval

Ethical approval was obtained from the Australian Catholic University (Australia) and the University of Central Lancashire (UK). Participation was voluntary and consent was implied by completion and return of the questionnaire.

Results

The overall survey response rate was 68%; 74% (n=63/85) in Australia and 64% (n=93/144) in the UK. The majority of respondents were stroke nurses (Australia: n=41, 66%; UK: n=65, 71%) and female (Australia: n=50, 79%; UK: n=74, 80%). Median years in role was 5 for Australia (Q1,Q3: 1.6, 8.0) and 5.8 for the UK (Q1,Q3: 3.2,8.6) (Table 1).

Insert Table 1: Respondent demographics and hospital characteristics by country

Forty-six per cent of Australian hospitals and 54% of UK hospitals were identified as a tertiary-level hospital. For all except one Australian hospital, use of an rt-PA protocol was reported.

Median rt-PA treatment rates were significantly greater in the UK (12%, interquartile range (IQR) 9.8-14.5) than Australia (8%, IQR 4.3-10.8) ($p<0.001$). Median door-to-needle times were also

significantly different between countries with shorter door-to-needle times in the UK (56 mins (IQR 45-66)) compared to Australia (78 mins (IQR 60-90)) (p< 0.001).

Stroke nurses' rt-PA administration practices

There were significant differences identified between the two countries for seven of the ten reported practices (Table 2), with UK stroke nurses more 'likely' compared to Australian stroke nurses to undertake these seven practices (*Requests the order for a CT scan; Screens patient for rt-PA suitability; Stroke telemedicine service contacted to assess, diagnose or treat; Gains informed consent from patient or family to perform rt-PA; Assists in the decision for suitability for rt-PA with emergency physician; Assists in the decision for suitability for rt-PA with neurologist/stroke physician; Undergo specific training in rt-PA administration*; $p < 0.05$ for all) .

Insert Table 2: Likelihood of stroke nurses' involvement in rt-PA administration practices in Australia and UK

Treatment rates for likelihood to undertake rt-PA administration practices

In Australia, there were significantly higher rt-PA treatment rates associated with five of the ten rt-PA administration practices that stroke nurses were reported as being likely to be involved in (*Reads and interprets CT scan; Screens patient for thrombolysis suitability; Gains informed consent from patient or family to perform thrombolysis; Assists in the decision for suitability for rt-PA with stroke physician/neurologist; Undergo specific training in rt-PA administration*; $p < 0.05$ for all) (Table 3). For our composite measure (involving all ten rt-PA practices) (mean=3.4, SD=2.7), nurses being likely to undertake more rt-PA administration practices was associated with increased rt-PA treatment rates in Australia with a 0.87 percentage point increase for each additional practice reported (Beta = 0.87, 95% CI:(0.28, 1.47), p = 0.0054). However, there were no significant increases in rt-PA treatment rates when a stroke nurse was likely to undertake any of the rt-PA administration

practices in the UK (Table 4). A significantly smaller rt-PA treatment rate of 10% was noted when stroke nurses in the UK were likely to contact the stroke telemedicine service to assess, diagnose or treat patients compared to when they were unlikely to contact the service (rate=14%) (p = 0.0032). For our composite measure (mean=5.6, SD=2.2) we found no association between increased nurse involvement in rt-PA administration and rt-PA treatment rate (Beta = 0.03, 95% CI:(-0.44,0.51), p = 0.8915).

Insert Table 3: rt-PA treatment rate by likelihood to undertake each practice in Australia

Insert Table 4: rt-PA treatment rate by likelihood to undertake each practice in UK

Discussion

This is one of the first international comparative studies to obtain a detailed snapshot of stroke nurses' involvement in patient selection, assessment and treatment with rt-PA, and also explored the association of stroke nurses' involvement in rt-PA practices with rt-PA administration rates in Australia and the UK. We found differences in nurses' involvement in the assessment and treatment of patients being considered for rt-PA, and an association between stroke nurses' role and rt-PA treatment rates within each country.

Nurses' involvement in rt-PA treatment practices

Compared to Australia, stroke nurses in the UK were more likely to be involved in seven of the ten rt-PA administration practices surveyed. However, participation levels in all practices in both countries could still be considered sub-optimal with scope for improving the involvement of the stroke nurse to deliver best clinical practice. A possible explanation for the minimal involvement of stroke nurses, particularly those in Australia, could be the lack of clarity and guidelines on which rt-PA related practices are considered within the scope of nursing practice (Birks, Davis, Smithson, &

Cant, 2016), for example ordering tests and obtaining patient consent. In a qualitative study undertaken in the UK, stroke nurses reported that they were not actively involved in the decision-making process for thrombolysis with the doctor primarily responsible for assessing patient eligibility for thrombolysis and administering rt-PA (Elmer Javier Catangui & Clifford John Roberts, 2014). Furthermore, stroke nurses are not located in Australian and UK Emergency Departments which means there is a reliance on effective communication between Emergency Departments and stroke wards to ensure stroke nurse presence in Emergency Departments. This organisational barrier may further limit their involvement in rt-PA administration.

Another explanation for minimal stroke nurse involvement in thrombolysis could be the resistance of some ED physicians to the evidence supporting rt-PA administration and it's use (Hoffman, 2003). This was highlighted in a recent process evaluation of an intervention aimed at improving treatment of patients with stroke in Australian EDs (McInnes et al., 2020; Middleton et al., 2019). In this study, the authors identified that the opposing views of Emergency Department physicians to rt-PA administration resulted in a negative flow-on effect on ED nursing staffs' views about use of thrombolysis.

Evidence from the UK suggests that nurses are able to safely administer rt-PA to eligible patients with ischaemic stroke as long as they have received appropriate training (Barclay J & Jones D, 2018; Puthenpurakal A & Crussell J, 2017). Specialised nursing education and training programs in vascular neurology can support stroke nurses safe involvement in thrombolysis practices (Brethour et al., 2012; Wojner Alexandrov et al., 2009). Our results showed that most UK stroke nurses had received some form of training in thrombolysis. However, education and training alone does not change historically entrenched clinical practice, particularly in the Emergency Department setting and education needs to be incorporated as part of a multidisciplinary evidence-based implementation

strategy that also considers context and social influences (McInnes et al., 2020; Middleton et al., 2019).

Our findings that administration of rt-PA without a physician in attendance or on a telemedicine call is occurring in both Australia and the UK, is of note. While these percentages are low (Australia: 21%; UK: 15%) these data are not routinely reported elsewhere and further exploration about when, where and in what circumstances this is occurring internationally would be of benefit. The likelihood of nurses reading and interpreting CT scans (Australia: 13%; UK 24%) is also noteworthy. Whilst still small, that nurses are becoming involved in neuroimaging interpretation demonstrates an extended scope of practice. Collectively, our findings support an enhanced role for stroke nurses in rt-PA administration with implications beyond the acute care setting into mobile stroke unit care which have been shown to reduce the time patients wait to receive life-saving acute stroke treatments, particularly rt-PA (Parker et al., 2015; Walter et al., 2012).

Stroke nurses' role and impact on rt-PA treatment rates

Nursing involvement was associated with better treatment rates in Australia, but not in the UK. The reason for this finding is unclear and investigating this further was beyond the scope of our study. Similarly, we are also unable to explain why the UK reported lower rt-PA treatment rates with the use of telemedicine. This finding may have potentially impacted on telemedicine physician preparation/confidence in making rt-PA treatment decisions, or poorer quality of the information conveyed about patient rt-PA treatment suitability.

Our study has some limitations, While our results suggest that the more active role of UK stroke nurses in rt-PA administration may contribute to higher treatment rates in the UK compared with Australia, this could be due to potential confounding factors such as years of nursing experience in the role, level of education, training and different country health systems. However, these factors

were not controlled for in the analysis. Finally, as with any self-report survey there is potential for response bias given the lack of external validation of the accuracy of responses. Despite these limitations, our study is strengthened by the high response rates, which were higher than that reported in the literature (Cook, Dickinson, & Eccles, 2009). Our study provides important implications for nursing practice and future research.

Implications for practice and future research

rt-PA treatment rates have been stagnating in both Australia (Stroke Foundation, 2019) (2017: 11%, 2019: 10%) and the UK (King's College London) (2017: 12%, 2019: 12%). Stroke nurses are ideally positioned to undertake a significant role in thrombolysis and formalising and extending the role of stroke nurses in rt-PA administration could have positive benefits for patients. Nurse-focussed roles in other areas of stroke care have been shown to have a significant impact on patient outcomes and savings in healthcare costs for a relatively small investment (Australian Commission on Safety and Quality in Health Care, 2017; Middleton et al., 2011). Having stroke nurses take on advanced roles to expedite evidence-based thrombolysis interventions could potentially improve patient outcomes and be cost-effective along the entire patient journey, from the emergency first responders on mobile stroke units or stroke ambulances (Fassbender et al.), through to hospital 'Code Stroke' response teams (Candelaresi et al., 2017; Kassardjian et al., 2017; Atte Meretoja et al., 2013). Additional nursing roles supporting thrombolysis prior to endovascular clot retrieval (Saver et al., 2013) and facilitating rapid admission to stroke unit care (Stroke Unit Trialists' Collaboration, 2013) are also important areas where nurses can enhance provision of proven evidence-based nursing protocols (Middleton et al., 2011). Novel models of care that maximise stroke nurses' role which may improve rt-PA treatment rates are urgently needed. Qualitative studies which aim to explore the perceptions and attitudes of other clinicians towards stroke nurses adopting an active role in all aspects of rt-PA administration are required, to identify barriers and facilitators to advanced role uptake.

Conclusion

This study provides new knowledge on the role of stroke nurses in the selection, assessment and decision-making for stroke thrombolysis and rt-PA administration in Australia and UK. For the first time, a clear overview of the variation in thrombolysis practices and level of involvement of stroke nurses in Australia and the UK is presented. Overall, stroke nurses in both countries play an important and active role in thrombolysis coordination but are currently underutilised in ensuring timely rt-PA administration. There is an international imperative to ensure all eligible patients receive rt-PA, made all the more compelling by stagnating and sub-optimal rt-PA treatment rates. Further investigation of formalising and extending the role of stroke nurses in thrombolysis administration is warranted to ensure all eligible patients receive timely acute stroke treatment to reduce death and disability.

Relevance to Clinical Practice

- Traditionally, physicians are responsible for thrombolysis treatment in eligible patients with stroke.
- There is a lack of information about the role of stroke nurses in thrombolysis administration.
- Our findings show that UK and Australian nurses play a very important role in thrombolysis practices, however, they are underutilised.
- Formalising and extending the role of stroke nurses in rt-PA administration could potentially increase thrombolysis rates with clinical benefits for patients.

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What does this paper contribute to the wider global clinical community?

- UK stroke nurses were significantly more likely to have a role in most aspects of thrombolysis treatment compared to Australian stroke nurses.
- In Australia, stroke nurses' involvement in a higher number of thrombolysis practices were associated with significantly higher treatment rates.
- In both countries, a small proportion of nurses are involved in neuroimaging interpretation demonstrating an extended scope of practice.

Table 1: Respondent demographics and hospital characteristics by country

Characteristic	Group	AUS *N=63* n (%)	UK *N=93* n (%)	p-value
Sex	**Female**	50 (79)	74 (80)	1.0000†
Age	**21-30 years**	3 (4.8)	7 (8.2)	
	31-40 years	15 (24)	22 (26)	
	41-50 years	22 (35)	32 (38)	0.1162
	51-60 years	18 (29)	24 (28)	
	over 60 years	5 (7.9)	0 (0)	
Education	**Diploma/Certificate**	4 (6.3)	25 (27)	
	Bachelors	26 (41)	32 (35)	
	Medical Degree	7 (11)	7 (7.6)	0.0052
	Masters Degree	25 (40)	23 (25)	
	PhD	1 (1.6)	5 (5.4)	
Participant role*	**Stroke Nurse**	41 (66)	65 (71)	
	Stroke Unit Director	4 (6.5)	4 (4.4)	
	Nurse Unit Manager	5 (8.1)	0 (0)	0.0944
	Registered Nurse	1 (1.6)	2 (2.2)	
	Physician	7 (11)	10 (11)	
	Other	4 (6. 5)	11 (12)	
Duration in role	**years, median (Q1, Q3)**	5 (1.6, 8.0)	5.8 (3.2, 8.6)	0.1711^
Hospital Type	**Tertiary**	29 (46)	50 (54)	
	Non-Tertiary	30 (48)	43 (46)	0.0459
	Private	4 (6.3)	0 (0)	
Door-to-needle time	**mins, median (Q1, Q3)**	78 (60, 90)	56 (45, 66)	<0.0001^
rt-PA treatment rate	**%, median (Q1, Q3)**	7.8 (4.3, 10.8)	12 (9.8, 14.5)	<0.0001^

***Missing data for one site in each country (Australia N=62; UK N=92)*

-Fisher's exact test used except where otherwise noted

†Chi-squared test

^Wilcoxon rank-sum test

Table 2: Likelihood of stroke nurses' involvement in rt-PA administration practices in Australia and UK

Stroke Nurses' role and involvement	Highly likely & Likely n (%)		p-value
	Aus (n=63)	UK (n=93)	
1. Requests the order for a CT scan	11 (18)	60 (65)	**<0.0001**
2. Reads and interprets CT scan	8 (13)	22 (24)	0.1344
3. Screens patient for rt-PA suitability	26 (41)	69 (74)	**<0.0001**
4. Stroke telemedicine service contacted to assess, diagnose or treat	11 (18)	40 (43)	**0.0016**
5. Gains informed consent from patient or family to perform rt-PA	13 (21)	43 (46)	**0.0024**
6. Assists in the decision for suitability for rt-PA with emergency physician	19 (30)	46 (50)	**0.0321**
7. Assists in the decision for suitability for rt-PA with neurologist/stroke physician	36 (57)	77 (83)	**0.0009**
8. Administers rt-PA with physician in attendance or on telemedicine call	36 (57)	66 (71)	0.1075
9. Administers rt-PA without physician in attendance or on telemedicine call	13 (21)	14 (15)	0.4912
10. Undergo specific training (either formal or informal) in rt-PA administration	36 (57)	76 (82)	**0.0015**

Table 3: rt-PA treatment rate by likelihood to undertake each practice in Australia

Stroke Nurses' role (N=63)	rt-PA treatment rate Median (IQR)		p-value
	Likely	Unlikely	
1. Requests the order for a CT scan	10 (4.4-14)	8 (4.3-12)	0.8412
2. Reads and interprets CT scan	14 (10-18)	7.3 (3.9-11)	**0.0130**
3. Screens patient for rt-PA suitability	10 (6-16)	5.8 (3.3-8)	**0.0048**
4. Stroke telemedicine service contacted to assess, diagnose or treat	7.7 (3.8-11)	8.3 (4.3-13)	0.5870
5. Gains informed consent from patient or family to perform rt-PA	12 (10-18)	7.2 (4.1-10)	**0.0242**
6. Assists in the decision for suitability for rt-PA with emergency physician	8.6 (4-12)	7.7 (4.3-15)	0.8298
7. Assists in the decision for suitability for rt-PA with neurologist/stroke physician	10 (6.6-13)	4.3 (3.4-6)	**0.0024**
8. Administers rt-PA with physician in attendance or on telemedicine call	8.8 (6.0-13)	6.3 (3.8-9.6)	**0.0297**
9. Administers rt-PA without physician in attendance or on telemedicine call	10 (8.8-18)	7.2 (4.1-11)	0.0639
10. Undergo specific training (either formal or informal) in rt-PA administration	9.3 (5.8-13)	4.1 (3.5-8.5)	**0.0255**

Table 4: rt-PA treatment rate by likelihood to undertake each practice in UK

Stroke Nurses' role and involvement UK, N=93	Treatment rate median (IQR)		p-value
	Likely	Unlikely	
1. Requests the order for a CT scan	12 (9.9-15)	11 (9.5-15)	0.7689
2. Reads and interprets CT scan	13 (9.1-15)	12 (9.8-15)	0.7364
3. Screens patient for rt-PA suitability	12 (8.8-15)	12 (10-14)	0.6868
4. Stroke telemedicine service contacted to assess, diagnose or treat	10 (8.4-14)	14 (11-20)	**0.0032**
5. Gains informed consent from patient or family to perform rt-PA	12 (9.8-15)	12 (9.5-14)	0.6160
6. Assists in the decision for suitability for rt-PA with emergency physician	13 (9.3-15)	12 (10-15)	0.6808
7. Assists in the decision for suitability for rt-PA with neurologist/stroke physician	12 (9.8-15)	11 (9.5-13)	0.1874
8. Administers rt-PA with physician in attendance or on telemedicine call	12 (8.7-15)	11.8 (11-14)	0.9645
9. Administers rt-PA without physician in attendance or on telemedicine call	12 (9.8-15)	12 (9.5-15)	0.8415
10. Undergo specific training (either formal or informal) in rt-PA administration	12 (9.8-15)	12 (9.5-14)	0.9805

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	4
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4, 5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5
Bias	9	Describe any efforts to address potential sources of bias	6
Study size	10	Explain how the study size was arrived at	NA
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	6
		(*c*) Explain how missing data were addressed	7
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	NA
		(*e*) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	7
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7
		(b) Indicate number of participants with missing data for each variable of interest	7
Outcome data	15*	Report numbers of outcome events or summary measures	7-9
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	7-9

		(*b*) Report category boundaries when continuous variables were categorized	8
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9
Discussion			
Key results	18	Summarise key results with reference to study objectives	9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	11
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9-11
Generalisability	21	Discuss the generalisability (external validity) of the study results	14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Title page

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.