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AUSCR

Australian Stroke Clinical Registry

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

The Australian Stroke Clinical Registry (AuSCR)

- The AuSCR provides a standardised approach for hospitals to monitor, review and improve stroke care in compliance with national acute stroke care standards.
- In 2018, the AuSCR continued to be an active partner in quality improvement projects in Queensland, Victoria, Tasmania, New South Wales and South Australia.

AuSCR participation in 2018

- In 2018, 71 hospitals contributed data to the AuSCR (39% from Victoria, 31% from Queensland, 21% from New South Wales and 4% each from Tasmania and South Australia).
- Information is presented on 18809 patients with 20051 admissions for acute stroke or transient ischaemic attack (TIA) and represents a 41% increase in total episodes from 2017.
- At 90-180 days after admission, collection of patient reported outcomes was completed for 69% of all eligible registrants which was unchanged from 2017. With more hospitals contributing data in 2018, the total number of completed follow-ups increased by nearly 4000 from 2017.
- 2018 was the first full calendar year of data collection for 15 acute thrombolytic centres across NSW funded by the Agency for Clinical Innovation (ACI) Foundation Program.

Hospital performance against clinical care standards

- Provision of stroke unit care was relatively stable at 75% compared with 73% in 2017, as was the rate of thrombolysis at 14% when compared to 13% in 2017. Overall rates of thrombolysis varied by significantly by state ($p<0.001$) and ranged from 7% (Tasmania) to 18% (South Australia). Thrombolysis rates also varied significantly ($p<0.001$) between metropolitan (15%) and regional hospitals (10%). Rates of thrombolysis were also significantly greater ($p<0.001$) at hospitals where endovascular clot retrieval was available (19%) compared to hospitals where this treatment was not available (11%).
- The proportion of patients receiving thrombolysis in under 60 minutes for ischaemic stroke decreased marginally to 35% from 38% in 2017. The overall median door-to-needle time was relatively stable at 71 minutes compared with 73 minutes in 2017. Patients treated at rural hospitals were less likely to have door-to-needle times less than 60 minutes when compared with those treated at metropolitan hospitals (20% vs 39%; $p<0.001$).
- The rate of thrombolysis provision for arrivals within 4.5 hours for ischaemic stroke was relatively stable at 29% compared with 31% in 2017. Significantly longer median door-to-needle times were observed for patients arriving sooner after stroke onset, when compared with those that arrived later ($p<0.001$).
- The proportion of patients prescribed medications at discharge were relatively stable in 2018 when compared with 2017 including: antihypertensives 72% (73% in 2017); antithrombotics 90% (88% in 2017) and lipid-lowering medications 76% (77% in 2017). Patients provided with all three medications at discharge were significantly more likely to be male (59% versus 53%; $p<0.001$) and live in a regional area (30% versus 26%; $p<0.001$).

- Provision of a discharge care plan for those discharged to the community was also relatively unchanged in 2018 at 62% compared with 59% in 2017.
- Performance benchmarks calculated for the AuSCR 2018 cohort show that the best performing hospitals could achieve: 99% for stroke unit care; 29% for thrombolysis of ischaemic stroke; 100% for door-to-needle times less than 60 minutes; 93% for antihypertensives; 100% for antithrombotics, 99% for lipid-lowering medications and 88% for discharge care plans.
- Several hospitals were found to be outside the limits set for normal variation in relation to key performance measures. Processes of care with the most variation were management in a stroke unit and provision of a discharge care plan.
- Comparisons of admissions between 8am and 6pm Monday to Friday, with after hours admissions, indicated that patients admitted after hours were significantly less likely to:
    - receive stroke unit care (74% versus 78%; $p<0.001$);
    - have a door-to-needle time less than 60 minutes (28% versus 41%; $p<0.001$);
    - receive endovascular clot retrieval therapy (17% versus 23%; $p<0.001$) and where endovascular clot retrieval therapy was provided the median door-to-groin puncture time was significantly longer for after hours admissions (89 minutes versus 67 minutes; $p<0.001$).
- 1757 patients (10%) were discharged from hospital on a weekend. Patients discharged over the weekend were significantly less likely to have received:
    - stroke unit care (67% versus 78%; $p<0.001$)
    - antihypertensive (66% versus 74%; $p<0.001$), antithrombotic (89% versus 92%; $p<0.001$) and lipid-lowering medications on discharge (71% versus 78%; $p<0.001$)
    - a discharge care plan (53% versus 64%; $p<0.001$).
- A total of 1098 patients at 15 hospitals received endovascular clot retrieval. The median time from arrival to groin puncture increased to 72 minutes from 54 minutes in 2017. Median arrival to recanalisation times increased to 116.5 minutes from 112 minutes in 2017.
- Overall, 1639 (8%) of the 2018 AuSCR registrants died in hospital. In addition to those who died in hospital, a further 1257 (6%) of the 2018 AuSCR registrants died within 180 days of their stroke following discharge compared with 8% in 2017.

Discharge destination and post-discharge outcomes

- After discharge from acute care, 25% of patients went to rehabilitation (23% in 2017) and 51% returned to their usual residence, with or without some form of support (50% in 2017). At the 90-180 day follow-up, 24% of patients reported being free of disability reporting no symptoms on the modified Rankin Scale.
- With respect to health-related quality of life as measured by the European Quality of Life measure of health status (EQ-5D-3L): 49% of patients reported problems with mobility, 30% with self care, 58% with completion of usual activities, 48% had pain/discomfort and 46% had anxiety or depression. The mean Visual Analogue Scale score was 68.
- Patients with intracerebral haemorrhage (ICH) reported a higher incidence of problems on all five dimensions of quality of life than patients with other types of stroke or transient ischaemic attack (TIA).

GOVERNANCE REPORT

The governance of the AuSCR adheres with the operating principles established by the Australian Commission for Safety and Quality in Healthcare.[1]

The AuSCR is governed by the Steering Committee chaired by Professor Sandy Middleton, by way of liaison with the AuSCR Management Committee chaired by Professor Natasha Lannin. The day-to-day registry operations are managed centrally by staff within the Florey Institute of Neuroscience and Mental Health (The Florey). The Registry Custodian is Professor Dominique Cadilhac (The Florey and Monash University). Subcommittees including the Research Task Group and clinical expert groups (including the Reperfusion and Telemedicine Subcommittee) support key registry operations and report to the Steering Committee.

Members of the Steering Committee, Management Committee, Research Task Group and Reperfusion and Telemedicine Subcommittee voluntarily contribute their time to ensure the rigorous operation and ongoing development of the Registry (see Appendices A, B and C for additional details on governance, membership lists and funding respectively). We thank Professor Craig Anderson for his contributions as Chair of the AuSCR Management Committee since 2009 and welcome Professor Lannin to this role as of September 2018. Professor Anderson will continue in his role as a member of the Management Committee.

In 2018, we welcomed the contribution of data for the first full calendar year from 15 acute thrombolytic centres in NSW which were funded by the Agency for Clinical Innovation Foundation Program. In addition, South Australia also has provided its first full calendar year of data from three hospitals which were funded by a research grant. The AuSCR also signed an agreement to fund the participation of two hospitals in the Australian Capital Territory (ACT) in collaboration with the Stroke Foundation and ACT Health and we look forward to their participation in 2019.

Use of AuSCR data for Quality Improvement (QI) initiatives continued in Queensland via the StrokeLink program with the Stroke Foundation and in Victoria via the Shared Team Efforts Leading to Adherence Results (STELAR) program funded by the Ian Potter Foundation. The use of AuSCR data for QI has now expanded to Tasmania with the Community of Practice program commencing, in collaboration with the Stroke Foundation.

In 2018, we commenced the planning and approval process for the inclusion of two new AuSCR datasets: the Fever, Sugar, Swallow (FeSS) and the Emergency Department (ED) datasets. The FeSS dataset builds on current AuSCR variables documenting swallow screening and assessment, with the addition of variables documenting monitoring of both fever and hyperglycaemia.[2,3] The ED dataset captures care provision in the ED prior to transfer for additional acute stroke care; this dataset was identified as required by hospitals, in particular those in regional centres, who were thrombolysing patients in the ED prior to hospital transfer. The addition of this dataset will enable hospitals to document all care provided to patients with stroke (i.e. both in the ED and following admission) and enable a more complete documentation of acute stroke care, nationally. The planned launch date for both datasets is mid-2019 and we look forward to showcasing these new datasets in the 2019 AuSCR Annual Report.

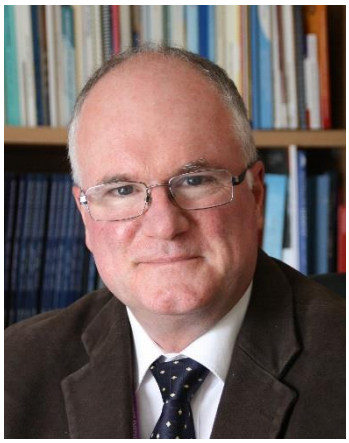
During the Stroke Society of Australasia conference in Sydney, the AuSCR hosted the first Investigator and Collaborators Forum. Stroke clinicians were invited from across Australia to attend. The Forum generated much discussion and input from everyone including Professor Avril Drummond and Professor Ben Bray from the SSNAP Stroke Registry (United Kingdom).

Highlights of the Forum included: the importance of clinical quality registry data for improving stroke care (Ben Bray); the use of AuSCR data to improve stroke care (Alexandra Warwick and Kim Parrey) and a panel discussion around current challenges to the clinical quality registries, both in Australia and internationally.

In 2018, the inaugural AuSCR awards were announced at the AuSCR Investigator and Collaborators Forum. These awards were presented to hospitals who achieved excellence in both the quality of acute stroke care provision and in the completeness of their AuSCR data. In total nine awards were presented in two categories. The recipients of these awards, along with the judging criteria, are included in Appendix G of this report. Well done to all award recipients and we hope that these awards inspire you, and others, to strive for improvements in acute stroke care.

The operational success of the AuSCR is due to the efforts of many organisations and individuals (see Appendix D), but we must particularly acknowledge the hospital staff who contribute to the AuSCR, as well as the patients, their carers and family members, without whom the registry could not exist.

Throughout the nine years of AuSCR data collection, the team has constantly endeavoured to share the findings and the learnings that have emerged. With the dataset having now reached a substantial size, considerable effort is being expended on preparing academic publications, particularly to highlight the gaps in clinical care that the AuSCR data are able to demonstrate empirically to inform policy and practice. AuSCR presentations and publications from 2018 are listed in Appendix E.



Professor Sandy Middleton
(Chair, Steering Committee)

Professor Craig Anderson
(Chair, Management Committee, January–August)

Professor Natasha Lannin
(Acting Chair, Management Committee January–August
Chair September – December)

Professor Dominique Cadilhac
(Florey Data Custodian)

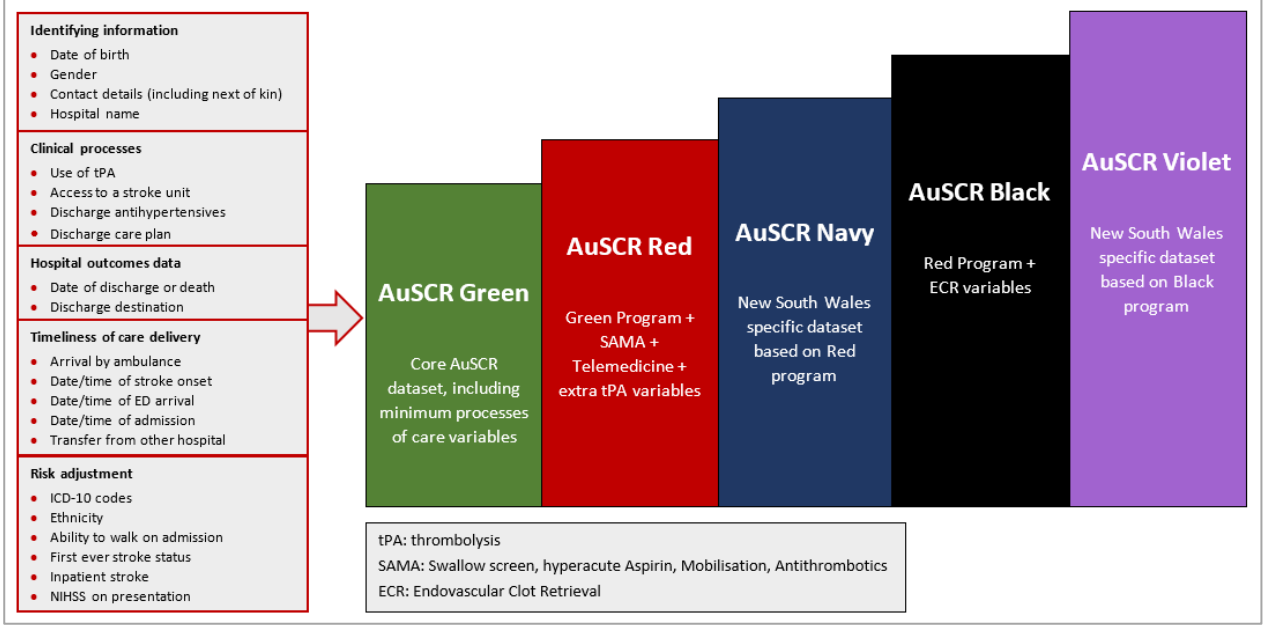
INTRODUCTION

The Australian Stroke Clinical Registry (AuSCR) is a collaborative national effort to monitor and support improvements to the quality of acute care for patients with stroke and transient ischaemic attack (TIA). Since 2009, the AuSCR has provided national data on consecutive patients admitted to hospital with acute stroke or TIA, which has been used to inform improvements to the health system.[4]

The AuSCR adheres to the national guidelines for best-practice in clinical quality registries,[1] and can be used by both public and private hospitals. Adult and paediatric cases are included. All participating hospitals are required to have ethics and site-specific governance approvals. As recommended for national registries, an 'opt-out' model for patient inclusion is used,[5] in addition to a waiver of consent for people who die while in hospital.

In the AuSCR, data are collected on the provision of evidence-based therapies, supplemented with clinical and demographic patient information, to provide an indication of the quality of acute stroke care received. Data are collected in the Australian Stroke Data Tool (AuSDaT) which is a harmonised online database platform enabling standardised and systematic data collection for multiple stroke data collection programs (Box 1). The AuSDaT enables hospitals to select bundles of variables organised into data collection programs, to enable local quality monitoring and state and national comparisons. All programs include the original national minimum processes of care for assessing quality of care.[4] In 2018, hospitals participated in five AuSCR programs, as illustrated in Figure 1. Note that two of these data collection programs (Violet and Navy) were only used by New South Wales (NSW) hospitals. Staff from participating hospitals can enter these data either manually via the web tool, by using a

FIGURE 1: AUSCR VARIABLE BUNDLES



data import process, or a combination of both. Each hospital has access to their own data and to real-time downloadable reports of summary data to enable regular reviews of hospital performance.

Patient reported outcomes are obtained via a questionnaire (including age-appropriate paediatric questions) at 90-180 days after admission. The AuSCR Office staff are responsible for following up registrants who have not:

- been reported as deceased;
- previously refused follow-up; or
- opted out of the registry.

For registrants unable to be contacted, survival status is determined via annual data linkage with the National Death Index (NDI) made available by the Australian Institute of Health and Welfare.

As the registry has matured, the large amount of cumulative data available permits analyses that can inform Australian policy and planning in relation to a range of epidemiological or health system issues, including examination of particular patient sub-groups. In addition, approved third parties can access aggregated, anonymised data to address their own research questions, or to recruit registrants for studies. (See Appendix F for a list of the 2018 applications to the AuSCR Research Task Group).

In 2018, the ***major*** sources of funding for the registry were: the Victorian Government; Queensland Health; the Tasmanian Government; the Agency for Clinical Innovation (New South Wales), industry, Monash University and the Victorian Stroke Telemedicine (VST) program (see Appendix C). Where state government funding was unavailable, hospitals participated under a ***user pays*** system. Ongoing discussions continue in other states and territories to procure funding support that will ensure representative data that can inform the provision of evidence-based stroke care nationally.

The data presented in this 2018 report provide insights into the care received, and the health outcomes, for 20051 episodes of care for 18809 patients from 71 Australian hospitals.

BOX 1: AUSCR VARIABLES COLLECTED IN THE AUSTRALIAN STROKE DATA TOOL

Identifying information

- Name
- Date of birth
- Sex
- Address
- Telephone number/s
- Hospital name
- Medicare number
- Hospital UR number
- Contact details for next of kin and alternative contact

Patient/episode characteristics

- Country of birth
- Language spoken
- Interpreter needed
- Aboriginal and Torres Strait Islander status
- Type and cause of stroke
- Date and time of stroke onset
- *Validated stroke screen and type*
- Date and time of arrival at ED
- Date and time of admission
- In-patient stroke status
- Transferred from another hospital status
- Ability to walk independently on admission
- First-ever (incident) stroke event status
- National Institutes of Health Stroke Scale (NIHSS) Score on presentation
- Arrived by ambulance
- *Transfer to other wards*
- History of known risk factors
- *Dependency prior to admission*

Indicators of evidence-based care

- Treatment in a stroke unit
- Date and time of first brain scan
- Use of tPA if an ischaemic stroke
- Discharged on an antihypertensive agent
- Care plan provided at discharge (any documentation in the medical record)
- Telemedicine consultation
- Date and time of thrombolysis
- Adverse event related to thrombolysis
- Swallow screen and formal speech pathologist assessment
- Aspirin administration, <48 hours
- Mobilisation during admission
- *Mood assessment*
- Discharged on antithrombotic medication
- Discharged on lipid-lowering drugs

Allied health management

- *Patient seen by a physiotherapist, occupational therapist, speech pathologist, social work, dietitian*
- *Commencement of rehabilitation therapy*

Communication and support for patient and family/carer

- *Carer receiving relevant training and support needs assessment*

Complications during hospital admission

- *Aspiration pneumonia, deep vein thrombosis, falls, pulmonary embolism, symptomatic haemorrhagic transformation, new onset atrial fibrillation, stroke progression, urinary tract infection*

Further rehabilitation

- *Rehabilitation plan documented*
- *Rehabilitation referral made*

Endovascular clot retrieval (ECR) variables

- Date and time of subsequent brain scan
- Provision of ECR, including date and time
- NIHSS: before ECR and 24 hours after ECR
- Site of occlusion
- Final eTICI (expanded thrombolysis in central infarction) score
- Adverse event related to ECR

Hospital outcomes/discharge data

- In-hospital death
- Date of discharge/death
- Discharge destination
- ICD-10 diagnosis codes and procedures
- *Functional status on discharge*

Follow-up variables 90 to 180 days after admission

- Survivor status
- Place of residence
- Living alone status
- Subsequent stroke since discharge
- Readmission to hospital
- Quality of life
- Modified Rankin Scale
- Would like an information pack from the Stroke Foundation
- Would be willing to participate in future research

Note:

Different programs within the AuSCR collect different bundles of variables, depending on hospital resources and priorities. Items in italics are variables which are collected only as part of the NSW Foundation Program.

METHODS

ENSURING DATA QUALITY

From the outset, there have been consistent efforts to ensure complete and accurate data entry in the AuSCR. These quality control processes include:

- A comprehensive data dictionary with help notes to guide data entry (consistent with the National Stroke Data Dictionary).
- Database with built-in logic checks and variable limits to reduce the likelihood of data inaccuracies.
- Mandatory fields to reduce missing data.
- Integrated functions to identify duplicate entries and multiple patient records (for a single episode), which may be merged if necessary.
- AuSCR training for staff at newly participating hospitals and new staff at existing hospitals, completed in person or via videoconference.
- Resources available on the AuSCR website containing training videos and written information.
- Reports back to hospital staff on missing and discrepant data reports, produced bi-annually.
- AuSCR Office staff conduct audits of randomly selected medical records.
- Bi-annual case ascertainment assessments, completed by cross-checking hospital discharge codes of all eligible admissions (based on the ICD-10 principal diagnosis codes related to stroke/TIA) with the episode data entered in the AuSCR.
- A detailed manual, and training by AuSCR staff, to ensure standardised data collection and interpretation.
- Fact sheets, webinars, regular electronic newsletters for dissemination of new information, reminders and updates.

The ***AuSCR Annual Data Quality Report*** is a summary of data quality for the final 2018 dataset (e.g. time to record creation; data completeness; case ascertainment). A copy of this report can be obtained on the AuSCR website at https://auscr.com.au/about/annual-reports/

OVERVIEW OF DATA ANALYSIS

The AuSDaT platform has enabled the AuSCR to implement multiple data collection programs (variable bundles), of which five were used in 2018 (Figure 1). All programs contain core variables, and differences allow individual hospitals to choose a program that are aligned to their operations, e.g. use of telemedicine or endovascular clot retrieval (ECR). Program selection may also be guided by their state health department policies.

The data presented in this report include information on patients admitted to participating hospitals between 1 January and 31 December 2018. Data entry for these acute stroke/TIA episodes, and the associated follow-up questionnaires, was closed off, and data extracted, on 19 August 2019.

Duplicate data were checked by the AuSCR Data Manager using registrant identifiers (name, date of birth, Medicare number or hospital medical record number) and date of stroke onset, arrival, admission or discharge. Data cleaning was undertaken by the AuSCR Office staff before the data were extracted and de-identified for analysis. A second level of data checking was performed by authorised Monash University statisticians.

For all process of care analyses presented in this report, ***episodes with missing information are included in the denominator***, because, if the data were not provided, it was assumed that care related to that indicator was not offered. For the secondary prevention medications provided at discharge from hospital, patients who were indicated as being contraindicated were excluded from the denominator. Other performance measures based on published standards such as door-to-scan, door-to-needle, door-to-puncture and door-to-revascularisation times were also calculated. These were calculated using dates and times of arrival to hospital and treatment. When dates and times were missing, these performance measures were not calculated. Negative times were excluded from analyses.

In the case where a specific process of care for any individual hospital contained greater than 30% missing data, these hospitals were excluded from any subsequent analyses of the specific process of care. Time to thrombolysis, time to brain scan, time to dysphagia screen/assessment, and days to mobilisation were also excluded when there were more than 30% of data missing for thrombolysis, brain scan, dysphagia screening/assessment and mobilisation variables. Data related to ECR were not excluded due to missing data.

Hospital postcodes were mapped to the Accessibility/Remoteness Index for Australia 2011 (ARIA+) available from the Australian Bureau of Statistics (see www.spatialonline.com.au/ARIA_2011). The ARIA+ is used to calculate remoteness and accessibility, based on road distance, to 'service centres' (defined as populated localities where the population is greater than 1000 persons, of which there are 201). For this report ARIA+ Category 1 was defined as a major city and ARIA+ Categories 2 and 3 were combined to indicate a regional location. Descriptive information about paediatric cases (aged under 18 years) were not included in the overall patient characteristics, clinical and outcome data analyses.

Benchmarks for AuSCR national indicators were calculated based on a modified version of the Achievable Benchmark of Care (ABC™) methodology[6] which has been used and validated by Hall et al., 2013.[7] Only hospitals that had submitted at least 50 cases were eligible for inclusion. An Adjusted Performance Fraction (APF) score was then calculated for each hospital for the process of care indicators. This approach allowed adjustment for under or over inflation due to small numbers present at some hospitals. The benchmarks were calculated as the mean APF scores of the top performing hospitals that represented at least 15% of the sample of eligible patients. We also report national averages and adherence achieved by the top ranked hospitals from the

sample of hospitals that had registered at least 50 episodes of care.

Unless otherwise stipulated, the follow-up data were analysed using descriptive statistics and multi-variable logistic regression, with adjustment for patient casemix using age, sex, stroke type, ability to walk on admission (stroke severity), inpatient stroke, and patient transfer from another hospital, as appropriate.

All episodes were eligible for follow-up except:

- where acute data were not entered by the hospital within 180 days post-admission; or
- for those patients who were reported as deceased prior to the 90-180 day follow-up.

In the case where there was a second admission within 180 days of the first admission, follow-up was only completed for the first admission.

Using data obtained from linkage to the NDI, ***casemix adjusted survival analysis*** for deaths up to 180 days following admission was performed for those who had experienced an episode of care in 2018. Cox proportional hazards regression analysis was also performed on survival status for those who received stroke unit care, compared with those who did not. This was adjusted for age, sex, stroke type, inpatient stroke, transfer from another hospital and ability to walk on admission.

Health-related quality of life (HRQoL) is measured in the AuSCR using the European Quality of Life measure of health status (EQ-5D™), specifically the three level version of the instrument EQ-5D-3L. The EQ-5D-3L is a standardised instrument for use as a measure of health outcome (see http://www.euroqol.org/). It provides a simple descriptive profile across five dimensions: mobility, self-care, usual activities, pain and discomfort, and anxiety and depression. Each profile is divided into three levels: no problems (1), some or moderate problems (2) and extreme problems (3). Additionally, the EQ-5D-3L includes a self-rated summary score of overall health using a Visual Analogue Scale (VAS) with a range of responses from zero (worst imaginable health) to 100 (the best imaginable health state).

Risk adjusted mortality rate (RAMR) for each hospital at 30 days after admission was calculated. To ensure reliable estimates, analyses were conducted for individual hospitals that provided at least 200 episodes in 2017 and 2018 combined for cases of ischaemic stroke and greater than 50 episodes for intracerebral haemorrhage (ICH). Patients transferred from another hospital, in-hospital strokes and patients with TIA were excluded. The methods for calculating the RAMR for each hospital involved dividing the risk adjusted hospital specific mortality by the risk adjusted average hospital mortality, and then multiplying by the unadjusted proportion of deaths in the whole sample. Significant mortality variation was defined as 'normal variation' (95% values) for hospitals within two standard deviation (SD) limits, and 'significant variation' (99% of values) for hospitals above three SD limits.

Variability between hospitals in the proportion of patients with VAS scores was compared using the same methodology as for the calculations of the RAMR.

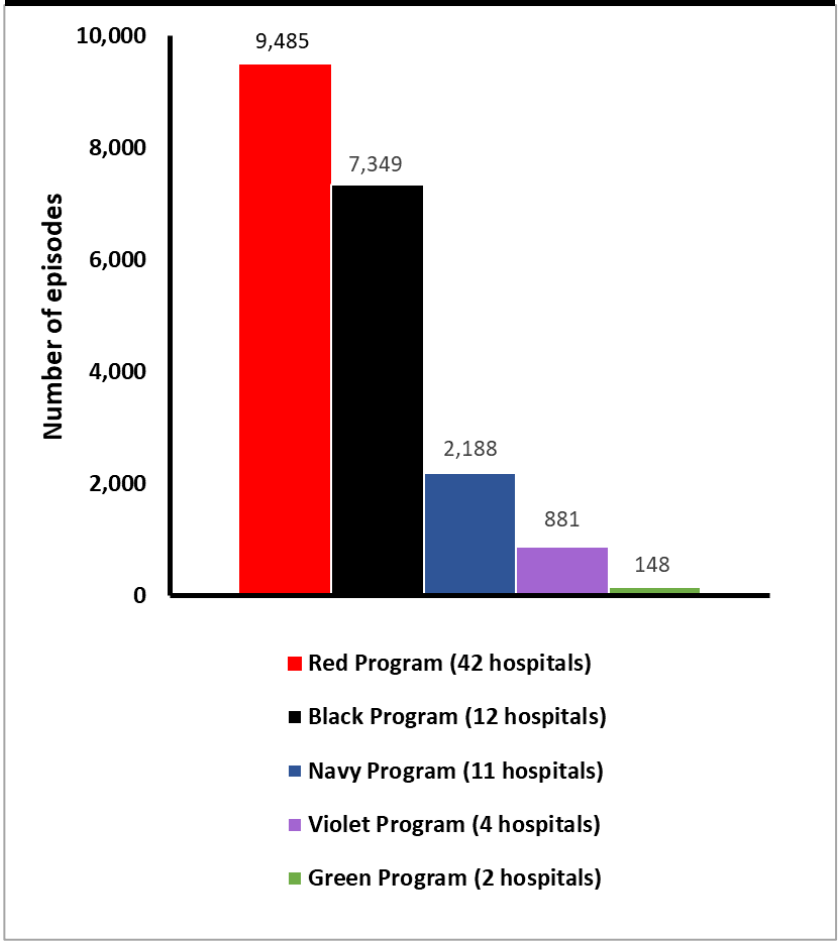
All analyses were performed using STATA/SE 15.1 (College Station, USA, 2018).

CHARACTERISTICS OF HOSPITALS AND PATIENTS IN 2018

HOSPITALS

In 2018, 71 hospitals provided data for 20051 episodes of admitted care (Figure 2). The majority of hospitals (n=42) used the Red data collection program (demographics, indicators of evidence-based care, hospital outcomes and discharge data, additional variables related to provision of intravenous thrombolysis), while another 12 hospitals used the Black data collection program (the same as the Red program plus ECR variables; Box 1). In NSW, 11 hospitals used the Navy program and four used the Violet program, which contained additional state specific variables in addition to the Red and Black programs. Two hospitals (one paediatric and one regional) used the Green program which is a minimum dataset of demographics and core processes of care.

FIGURE 2: NUMBER OF EPISODES ENTERED IN 2018, BY DATA COLLECTION PROGRAM



The characteristics of the 2018 participating hospitals are shown in Table 1. In 2018, there were 15 hospitals located in NSW, 22 in Queensland (QLD), 28 in Victoria (VIC), and three each in Tasmania (TAS) and South Australia (SA). Of the 71 hospitals, one was a private hospital located in QLD and one was a children's hospital in VIC. There were 38 hospitals located in a major city. Overall, 65 participating hospitals had a stroke unit and 64 that provided thrombolytic therapy using intravenous tissue plasminogen activator (tPA). Fifty-six hospitals registered 100 or more episodes of stroke/TIA during 2018.

TABLE 1: CHARACTERISTICS OF PARTICIPATING HOSPITALS

Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018					
	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	*QLD*	*VIC*	*TAS*	*SA*	*NSW*
Number of hospitals	6	12	16	31	37	40	40	48	59	71	*22*	*28*	*3*	*3*	*15*
Annual number of episodes in the AuSCR*															
Low (<33 episodes)	0	1	4	11	2	2	2	2	7	2	*0*	*2*	*0*	*0*	*0*
Medium (33-99 episodes)	1	5	2	6	8	8	6	6	10	13	*1*	*10*	*0*	*0*	*2*
High (≥100 episodes)	5	6	10	14	27	27	32	40	42	56	*21*	*16*	*3*	*3*	*13*
Location#															
Major city	6	10	11	16	28	28	20	27	31	38	*14*	*11*	*2*	*3*	*8*
Regional/Rural	0	2	5	15	9	9	20	21	28	33	*8*	*17*	*1*	*0*	*7*
Stroke unit	6	10	14	28	35	35	38	43	53	65	*22*	*23*	*2*	*3*	*15*
Used telemedicine	0	0	0	0	0	0	27	29	40	58	*20*	*22*	*2*	*2*	*12*
Intravenous thrombolysis undertaken	6	9	10	22	31	31	38	46	51	64	*20*	*23*	*3*	*3*	*15*
Endovascular Clot Retrieval undertaken	n/a	n/a	n/a	n/a	n/a	n/a	9	9	13	15	*3*	*5*	*1*	*2*	*4*

**Hospital categories as per the definitions used in registry of the Canadian Stroke Network*

#*Location categorised using Accessibility/Remoteness Index for Australia 2011 (ARIA+): Major city = category 1, Regional = categories 2 and 3*

REGISTRANTS

In 2018, there were 18809 patients registered in the AuSCR (Table 2). During a calendar year, patients may have multiple admissions for stroke or TIA that are eligible for inclusion in the AuSCR. In 2018, there were 20051 episodes of acute hospital care entered in the AuSCR for the 18809 individuals registered, with 1242 (6%) being recurrent episodes. A total of 20026 adult episodes of care were captured in the AuSCR in 2018.

The median number of episodes per hospital was 223 (Q1 to Q3: 133 to 370). The minimum number of episodes registered for any particular site was 14 at a metropolitan children's hospital in VIC and the maximum number registered was at a metropolitan hospital in VIC (n=1117).

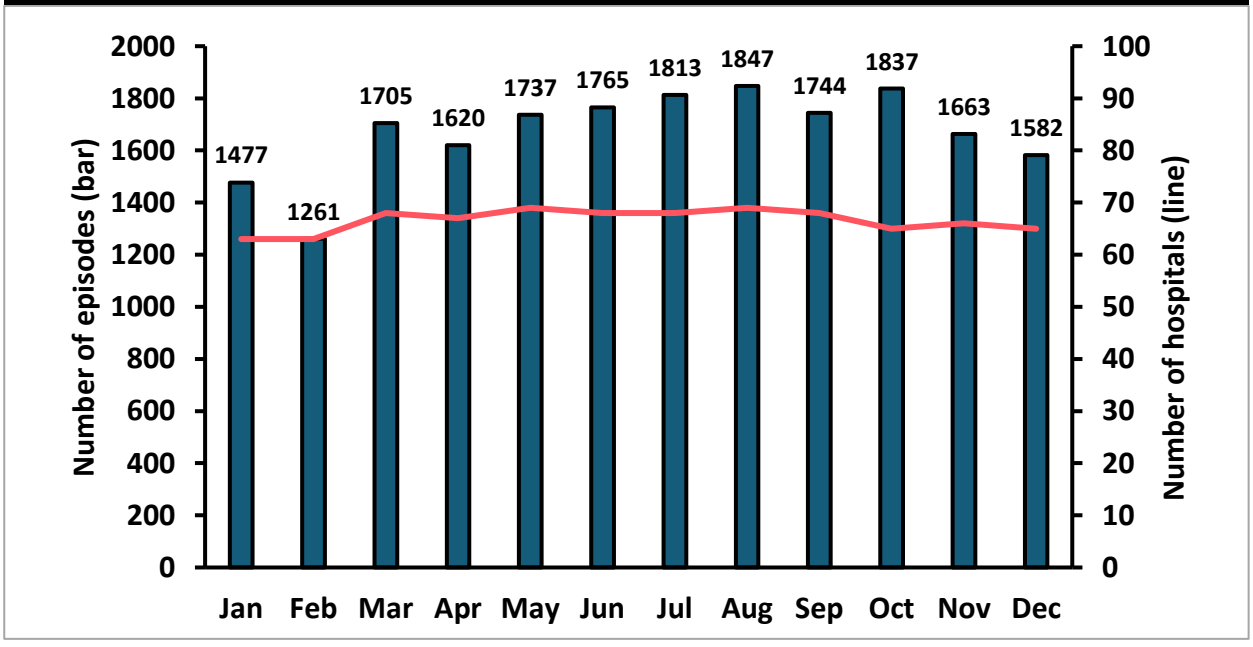
TABLE 2: NUMBER OF HOSPITALS, PATIENTS AND EPISODES IN 2018

Number of hospitals contributing data	71
Number of episodes submitted	20051
Number of patients	18809
Number and percentage of multiple episodes	1242 (6%)

EPISODES PER MONTH

Figure 3 shows the number of episodes (including multiple episodes) per month based on date of admission. The median number was 1737 (Q1 to Q3: 1620 to 1813) per month. The minimum was 1261 in February and the maximum was 1847 in August.

FIGURE 3: NUMBER OF EPISODES AND HOSPITALS CONTRIBUTING DATA IN 2018



REGISTRANT CHARACTERISTICS

Table 3 provides the baseline characteristics of patients and information related to their episodes of care. Adult and paediatric cases of stroke are presented separately. Nine hospitals admitted paediatric cases (patients aged <18 years) in 2018.

Among the 18,785 adult registrants, the most common country of birth was Australia (71%) followed by the United Kingdom (6%). The remainder were from a range of mainly European or Asian nations. There were 381 adult patients (2%) who identified as having an Aboriginal or Torres Strait Islander background. The majority of the registered adult patients spoke English (93%). The adult registrants had a mean age of 73 years, and 8,270 (45%) were female.

TABLE 3: BASELINE CHARACTERISTICS (ADULTS AND PAEDIATRICS)

Patients	Adults (n=18,785)	Paediatrics (n=24)
Episodes	**20,026**	**25**
Age in years, mean (SD)	73 (14)	8 (7)
Age in years, median (Q1 to Q3)	75 (65 to 84)	9 (1 to 16)
Female, n (%)	8,270 (45)	12 (50)
Country of birth, n (%)		
Australia	12,231 (71)	22 (96)
United Kingdom	1,110 (6)	0 (0)
Italy	474 (3)	0 (0)
Other European countries	1,516 (9)	0 (0)
Asia	875 (5)	1 (4)
Others	938 (5)	0 (0)
Aboriginal and/or Torres Strait Islander, n (%)	381 (2)	2 (8)
English spoken, n (%)	15,413 (93)	22 (96)

SD: standard deviation
Q1: 25th percentile
Q3: 75th percentile

CLINICAL CHARACTERISTICS

Of the 20026 adult episodes, clinicians indicated that there were 13989 ischaemic strokes, 2515 intracerebral haemorrhages (ICH), 2806 TIAs and 493 episodes of undetermined stroke type. There were 223 episodes where the stroke type was missing (Figure 4). Of the episodes with missing or undetermined stroke type for clinical diagnosis, ICD-10 codes were provided for 598 cases, which comprised ischaemic stroke (n=184), ICH (n=27), undetermined (n=283) and TIA (n=104) (see Figure 5).

Among the adult episodes, 46% of patients were able to walk at the time of admission. There were 3356 episodes (17%) transferred from another hospital and 811 episodes (4%) that occurred while patients were already in hospital for another condition. The majority of the inpatient episodes were ischaemic (n=670, 83%) and most of these (n=255, 33%) occurred among patients aged between 75 and 84 years. The median length of stay was longer for patients who had an episode while already in hospital for another condition (inpatient median 11 days [Q1 to Q3: 6 to 19 days] vs. median 4 days [2 to 7 days] for those presenting from the community, p<0.001). Patients who had an episode while already in hospital for another condition were treated in a stroke unit less often than those who presented from the community (57% vs 77%, p<0.001).

Among the 2806 episodes of TIA, the mean age was 73 years (SD 14 years), 48% were female and the median length of stay was one day (Q1 to Q3: 1 to 3 days).

FIGURE 4: DISTRIBUTION OF STROKE SUB-TYPES, BASED ON CLINICAL DIAGNOSIS

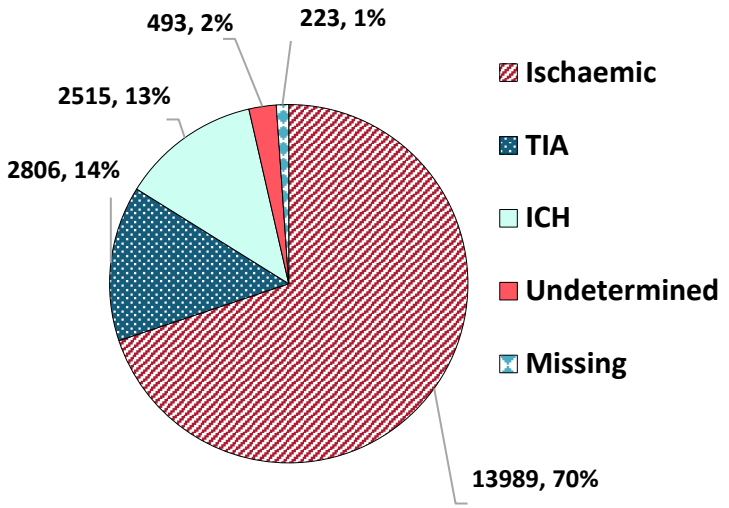
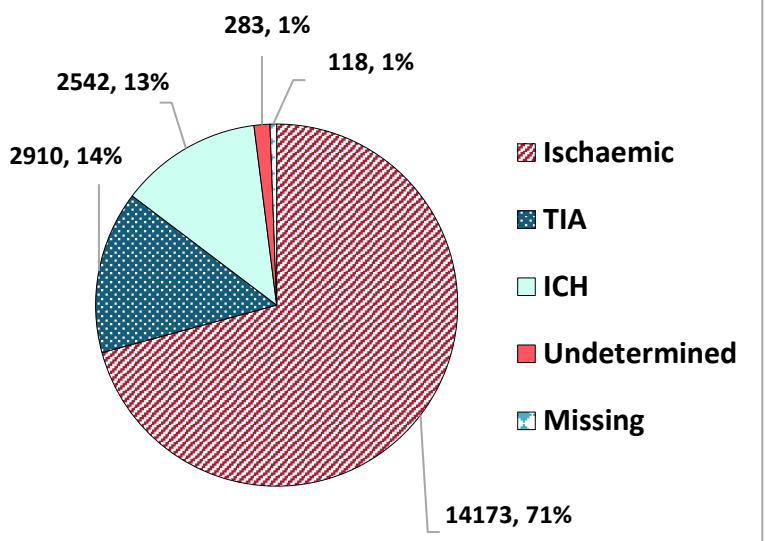


FIGURE 5: DISTRIBUTION OF STROKE SUB-TYPES, BASED ON CLINICAL DIAGNOSIS AND ICD-10 CODES



STROKE SEVERITY

There were 18417 episodes recorded where the patient had the ability to walk on admission (92% of the 2018 cohort) and 10006 episodes with a National Institutes of Health Stroke Scale (NIHSS) score recorded at time of presentation to hospital (50% of the 2018 cohort).

Patients with a diagnosis of ischaemic stroke had the lowest proportion of missing NIHSS scores (44%). The NIHSS score was recorded for 1078 episodes with a diagnosis of TIA (38%). There were 15 episodes (7%) with a missing stroke type for which a NIHSS score was recorded. Of the episodes receiving thrombolysis, a NIHSS score was missing for 11%. Episodes treated in a stroke unit had a greater proportion of NIHSS scores recorded than those treated in alternate ward settings (69% vs 44%, $p<0.001$).

Excluding those with TIA, there were 8481 episodes with both stroke severity variables recorded (Table 4). The greatest proportion of patients who were not able to walk on admission had a NIHSS score of between 5 and 15, indicating a moderate stroke (45%). Of those who were able to walk on admission, the majority (60%) had a NIHSS score of 1 to 4, indicating a minor stroke.

TABLE 4: NIHSS AND ABILITY TO WALK ON ADMISSION

	Ability to walk on admission	
National Institutes of Health Stroke Scale (NIHSS) categories	No n (%)	Yes n (%)
No stroke symptoms (0)	115 (2)	571 (16)
Minor stroke (1-4)	1154 (24)	2151 (60)
Moderate stroke (5-15)	2188 (45)	754 (21)
Moderate to severe stroke (16-20)	761 (16)	53 (1)
Severe stroke (21-42)	686 (14)	48 (1)
Total N	**4904**	**3577**

Excludes episodes of TIA

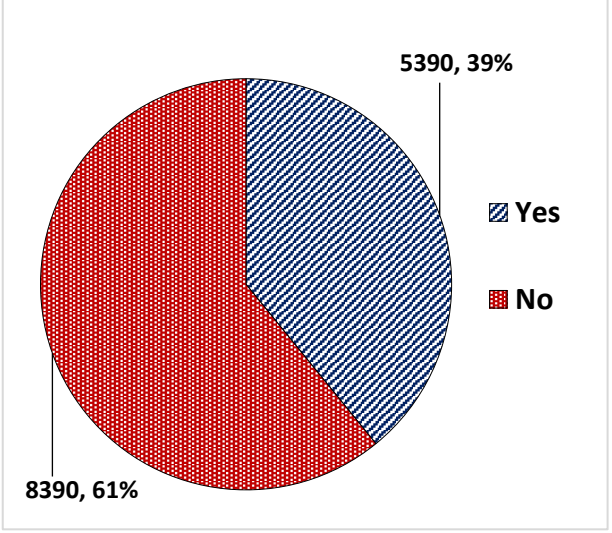
ACUTE CARE DATA

OVERALL ADHERENCE TO QUALITY INDICATORS

Arrival within 4.5 hours of symptom onset

5390 patients with ischaemic stroke (39%) arrived within 4.5 hours of symptom onset (Figure 6).

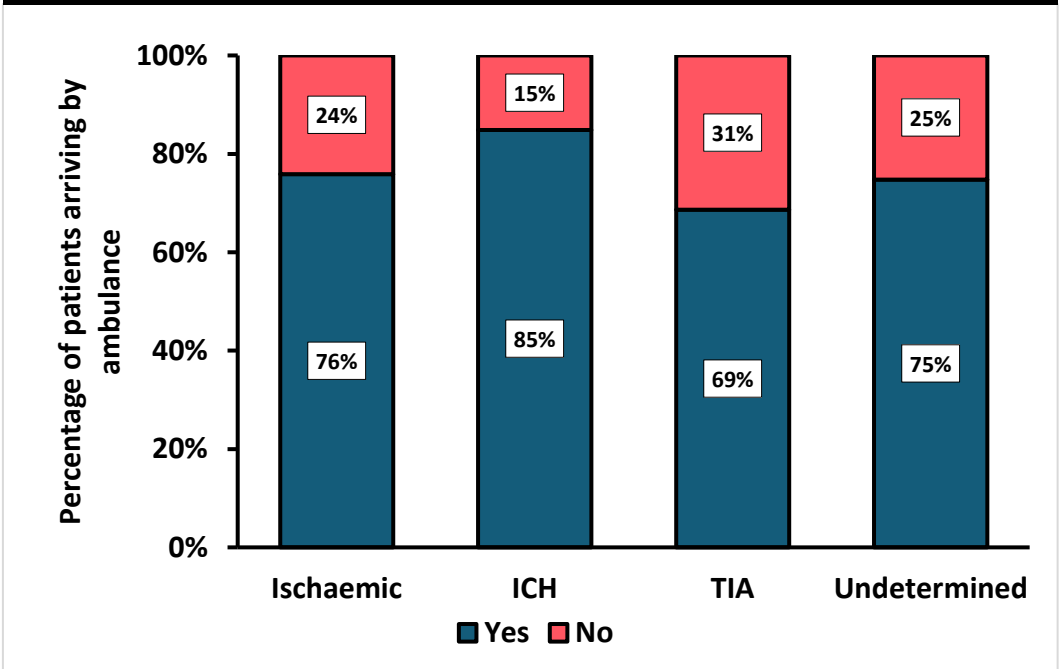
FIGURE 6: ARRIVAL WITHIN 4.5 HOURS OF SYMPTOM ONSET (ISCHAEMIC STROKE)



Arrival by ambulance

Method of arrival to the emergency department was collected for 18905 episodes. Of these, 14355 (76%) were transported by ambulance. The majority (80%) of the 3166 patients who were transferred from another hospital arrived by ambulance. A greater proportion of patients arriving by ambulance arrived within 4.5 hours of symptom onset than those patients arriving by other modes of transport (50% vs 28%, p<0.001). The proportion of patients arriving by ambulance was smallest for TIAs (69%), and greatest for ICH (85%), as seen in Figure 7.

FIGURE 7: ARRIVAL BY AMBULANCE, STRATIFIED BY STROKE TYPE



ICH: intracerebral haemorrhage
TIA: transient ischaemic attack

Stroke unit care

Three quarters of episodes (75%) were treated in a stroke unit (Figure 8). Of the patients with ischaemic stroke, 83% were treated in a stroke unit, compared to 69% of those with ICH, 52% of those with TIA and 55% of those with undetermined stroke type (Figure 9).

FIGURE 8: TREATED IN A STROKE UNIT

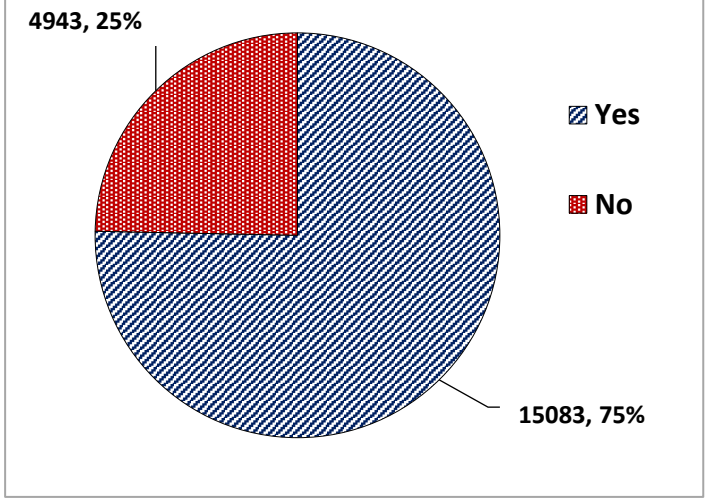
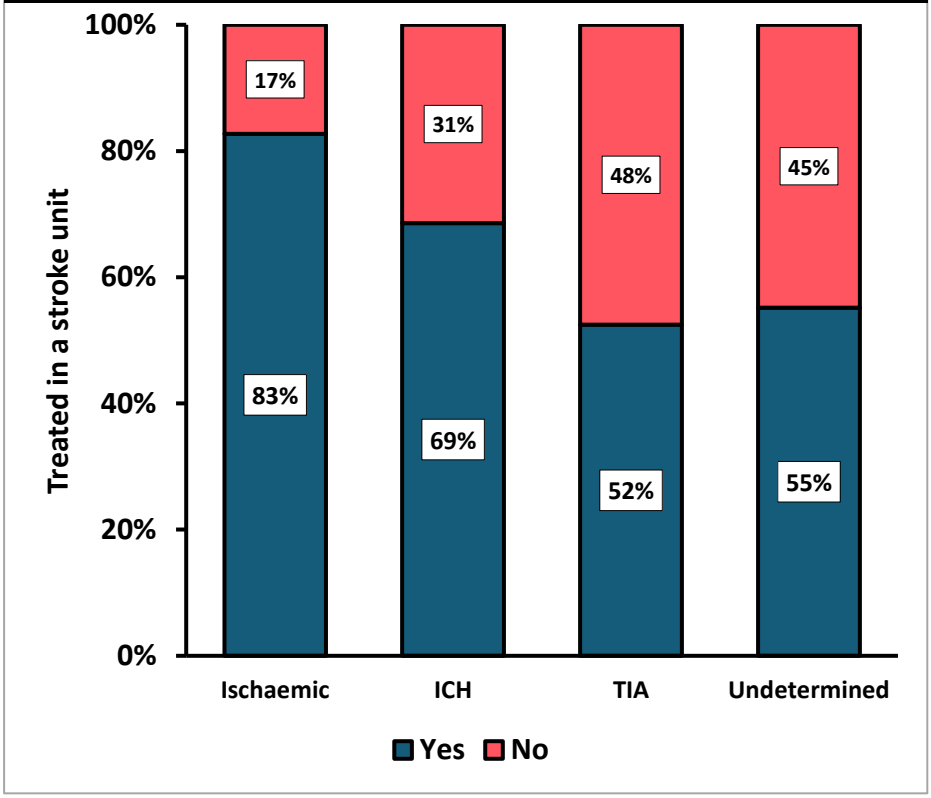


FIGURE 9: TREATED IN A STROKE UNIT, STRATIFIED BY STROKE TYPE



ICH: intracerebral haemorrhage
TIA: transient ischaemic attack

OTHER ACUTE ASSESSMENT AND MANAGEMENT PRACTICES

Hyperacute antithrombotic therapy

Due to changes in clinical guidelines, for the first time we have reported a combined measure for the hyperacute provision of any antithrombotic agent instead of provision of aspirin only. After excluding contraindicated cases and haemorrhagic stroke, hyperacute antithrombotic therapy was provided within 48 hours of stroke onset time in 71% of episodes.

Mobilisation

Overall, 83% of patients were mobilised during their admission with the majority of patients (66%) mobilised on the same day, or the day after, admission.

Dysphagia screening and swallow assessment

Dysphagia screening was undertaken in approximately half (54%) of all episodes, whereas a swallow assessment conducted by speech pathologists was completed in 71% of episodes in 2018 (Table 5). Overall, a dysphagia screen or assessment was conducted within four hours for 23% of episodes.

A dysphagia screen or speech pathologist assessment occurring *prior* to oral intake was documented in 49% of episodes.

TABLE 5: STROKE EVALUATION AND THERAPY

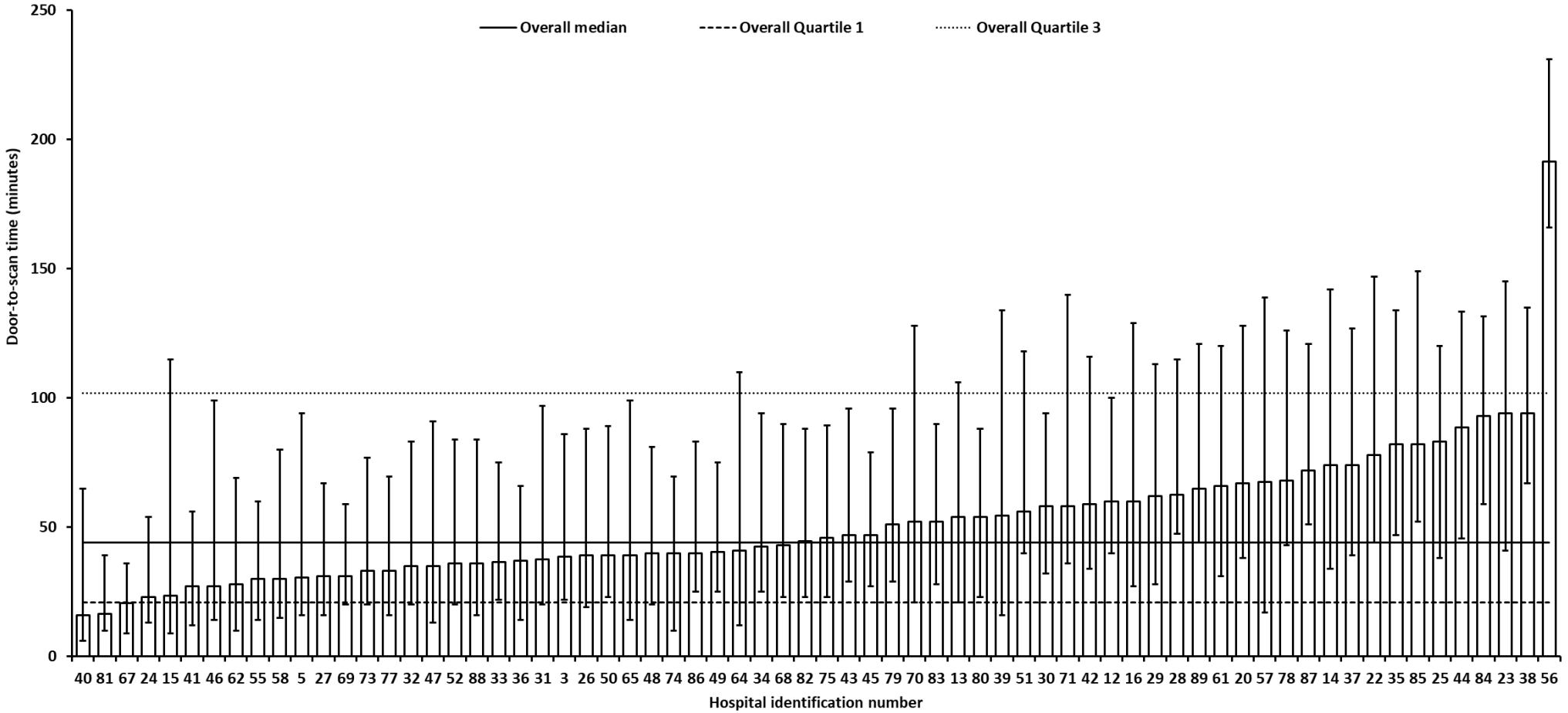
Hospital stroke care	All episodes	Ischaemic	ICH	TIA	Undetermined
Brain scan after stroke	98%	99%	99%	98%	95%
Antithrombotic therapy within 48 hours of stroke onset*	71%	71%	-	76%	63%
Mobilisation during admission	83%	87%	64%	88%	74%
Mobilised same day or day after admission	*66%*	*69%*	*44%*	*79%*	*62%*
If unable to walk independently, patient mobilised	77%	82%	56%	83%	60%
If unable to walk on admission, mobilised same day or day after	*57%*	*60%*	*36%*	*75%*	*50%*
Dysphagia screen conducted	54%	59%	41%	45%	47%
Screen within 4 hours	*20%*	*22%*	*13%*	*20%*	*16%*
Screen within 24 hours	*45%*	*49%*	*33%*	*41%*	*38%*
Swallow assessment conducted	71%	79%	61%	49%	58%
Assessment within 4 hours	*7%*	*7%*	*5%*	*6%*	*7%*
Assessment within 24 hours	*42%*	*46%*	*35%*	*33%*	*32%*
Dysphagia screen or assessment within 4 hours	23%	25%	16%	23%	19%
Dysphagia screen and/or swallow assessment prior to oral intake	49%	53%	47%	40%	41%

** Excludes intracerebral haemorrhage, contraindicated and those provided with another antithrombotic medication*

Brain scans

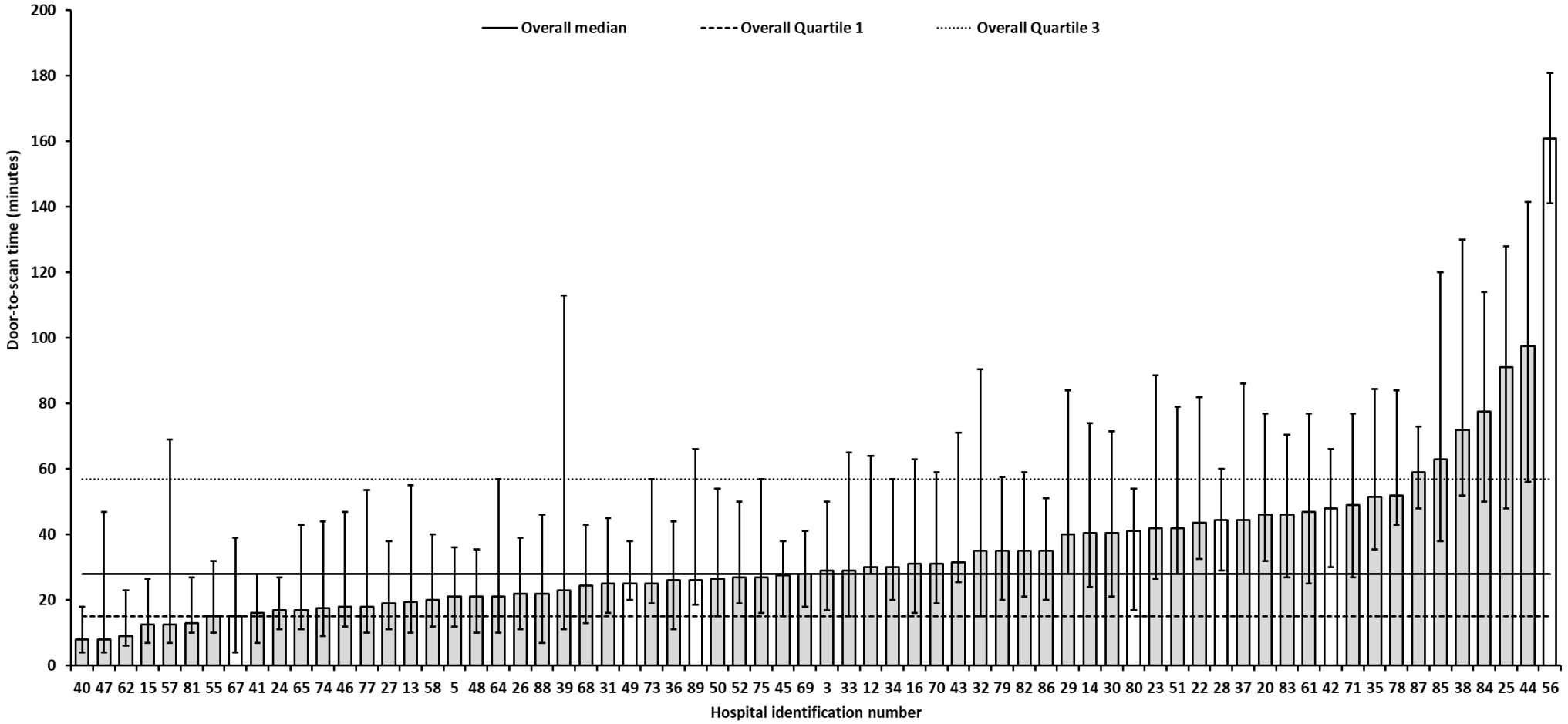
In the hospitals collecting data on the provision of brain scans (n=68), there was evidence that 98% of patients were provided a brain scan. There were 1146 patients who had a brain scan prior to transfer to the hospital at which they were admitted. Of those who had a brain scan after arrival to hospital, there were over 14,500 episodes where a time to brain scan was recorded. The median time to scan was 44 minutes, with five hospitals achieving a median time to scan of less than or equal to 25 minutes (Figure 10). The median time to brain scan from arrival was 28 minutes for patients with ischaemic stroke arriving within 4.5 hours of symptom onset (Figure 11).

FIGURE 10: MEDIAN DOOR-TO-SCAN TIME, BY HOSPITAL



Data for episodes where a scan was provided after 270 minutes of arrival are excluded
Number of episodes with door-to-scan times by hospital range from 10 to 837

FIGURE 11: MEDIAN DOOR-TO-SCAN TIME (ISCHAEMIC STROKE ONLY) ARRIVING WITHIN 4.5 HOURS OF ONSET, BY HOSPITAL



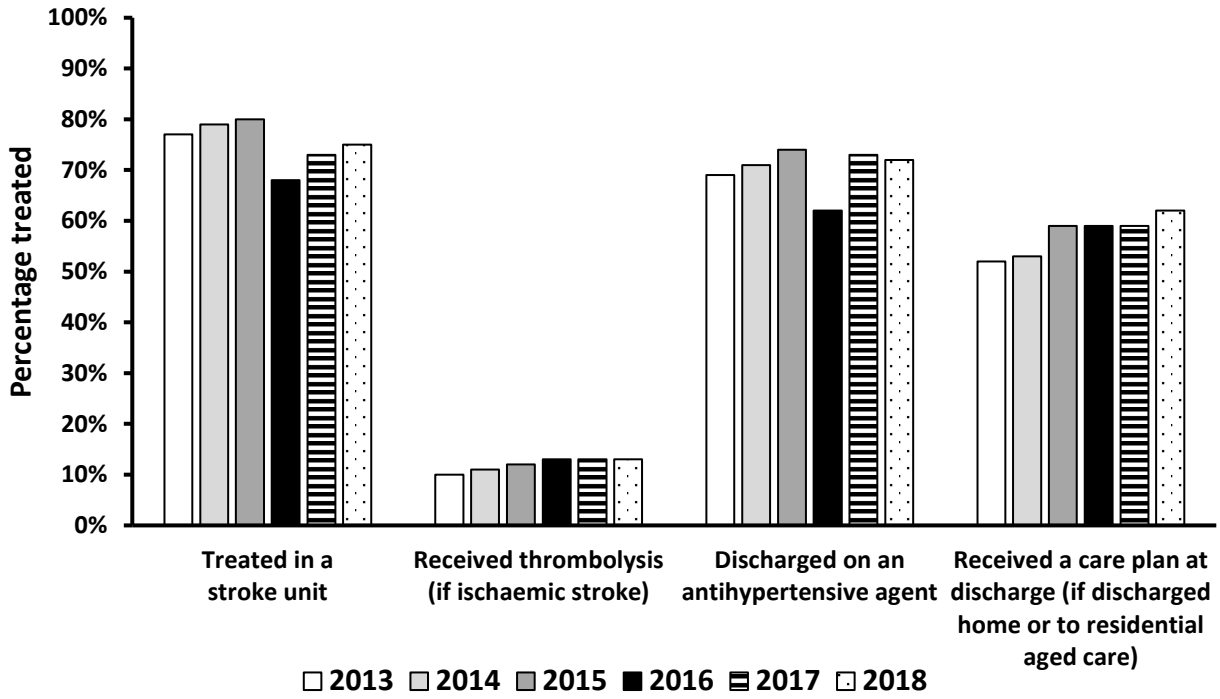
Data for episodes where a scan was provided after 270 minutes of arrival are excluded
Number of episodes with door-to-scan times by hospital range from 2 to 423
White bars represent hospitals with less than 10 episodes with door-to-scan times

CHANGES IN THE PROVISION OF QUALITY INDICATORS OVER TIME

Four quality indicators have been collected since the inception of the AuSCR. Compared with 2017 proportions of episodes receiving treatment in a stroke unit, and receipt of a discharge care plan for those discharged to the community setting have increased (Figure 12).

Aggregate data, and their analysis, has not been limited to hospitals that have contributed data consistently since 2013 and may therefore be influenced by different numbers and types of hospitals contributing data annually.

FIGURE 12: CHANGES IN QUALITY INDICATORS OVER TIME (NATIONAL AVERAGES)



ACHIEVABLE BENCHMARKS FOR QUALITY INDICATORS

The AuSCR benchmarks for the quality indicators compared to other commonly used performance metrics (i.e. adherence achieved by top performing hospitals or average adherence rates) are shown in Table 6. All of these quality of care indicators align with the current national clinical care standards for acute stroke.[8]

If the achievable benchmarks were reached by all AuSCR hospitals relative to the overall average adherence, then it is estimated that: a further 3756 patients would have benefited from care in a stroke unit; an extra 905 from intravenous thrombolysis if an ischaemic stroke; an extra 383 provided intravenous thrombolysis within 60 minutes of arrival; an additional 2540 from antihypertensive medication; 1242 from antithrombotic medication; 2483 from lipid-lowering medication; and 3424 being provided with a care plan if discharged into the community.

TABLE 6: NATIONAL STANDARDS QUALITY INDICATORS AND ACHIEVABLE BENCHMARKS

Process of care	Hospitals included*	Participant sample N	Average adherence (%)#	Top adherence (%)†	Benchmark 2018‡	Hospitals forming benchmark
Received stroke unit care	64	19771	76%	99%	95%	11
Received intravenous thrombolysis if an ischaemic stroke §	61	11311	13%	29%	21%	8
Door-to-needle time <60 minutes §	61	1319	34%	100%	63%	5
Received endovascular clot retrieval if an ischaemic stroke**	14▲	4619	14%	19%	19%	2
Mobilised on same day or day after admission	47	15330	66%	88%	78%	12
Discharged on antihypertensive medication^	64	16930	72%	93%	87%	14
Discharged on antithrombotic medication^	63	15520	90%	100%	98%	12
Discharged on lipid-lowering medication^	63	15520	76%	99%	92%	13
Care plan provided if discharged to the community	63	9110	62%	100%	98%	8

* *Only sites with ≥50 episodes registered were eligible for inclusion. Sites were ineligible if they did not participate in the appropriate data collection program or if >30% of data were missing for a particular variable.*
# *Average adherence results differ to those reported elsewhere because these are calculated in a sub-sample of hospitals as meeting the inclusion criteria.*
† *The top performer adherence results are the unadjusted scores for a single hospital in the sub-sample.*
‡ *Benchmarks were calculated based on a modified ABC™ method.* [6,7]
§ *Adherence and benchmarks related to thrombolysis exclude those who received thrombolysis prior to hospital arrival (e.g. prior to transfer).*
** *Adherence and benchmarks related to endovascular clot retrieval were calculated for patients with ischaemic stroke who were treated at a hospital providing endovascular clot retrieval and exclude those transferred from another hospital.*
▲ *Excludes one hospital in South Australia where only one patient was provided with endovascular clot retrieval*
^ *Excludes patients with contraindications*

ADHERENCE TO QUALITY INDICATORS

Adherence to quality indicators by number of episodes registered in 2018 for each hospital is illustrated by the funnel plots in Figures 13 to 19. Funnel plots can be used to display deviations from the average achievement of quality of care.[9] Note that all of the funnel plots below exclude paediatric cases. Hospitals contributing fewer than 50 episodes were excluded from all plots. Hospital data were also excluded from individual variable analyses if more than 30% of the data for that variable was missing.

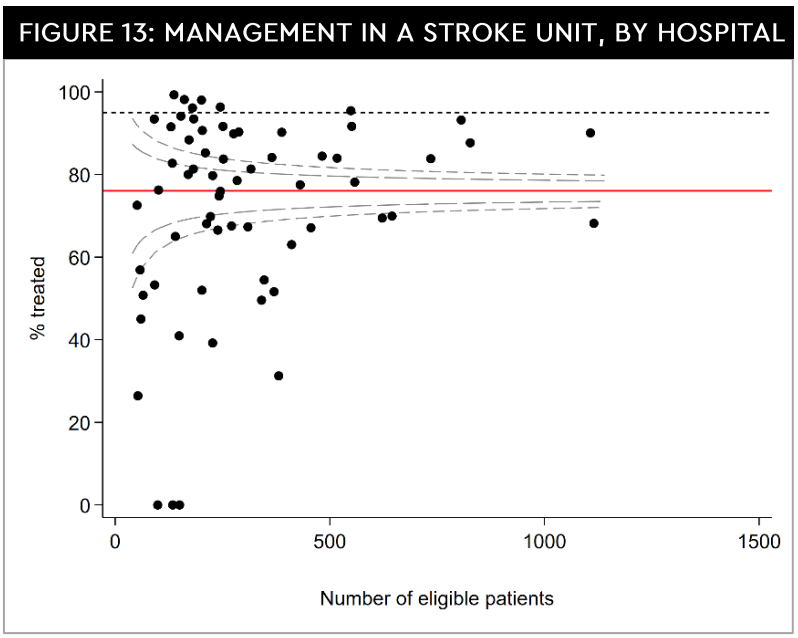
How to read the funnel plots

The horizontal axis depicts the size of the hospital in terms of the number of episodes e.g. the greater the number of episodes, the further to the right will be the representative dot. The vertical axis measures the adherence to quality indicators, expressed as a proportion (%). The horizontal solid centre line shows the overall (all hospitals combined) adherence, e.g. in Figure 13, the overall proportion of patients managed in a stroke unit was 75%.

The large dashed lines constitute the funnel based on standard deviation (SD). They are the upper and lower control limits that represent the boundary between 'normal variation' (two SDs from the mean) and 'special cause variation' (three SDs from the mean). The small dashed line indicates the achievable performance benchmark. Hospitals above the three SD limits line may be considered as having 'good performance', while those below the three SD limits line may be considered as having 'poor performance', relative to the sample average performance.

Care must be taken in interpreting these data when they are skewed because the control limits rely on the assumption that the distribution of data follows a bell curve or '*normal distribution*'.

FIGURE 13: MANAGEMENT IN A STROKE UNIT, BY HOSPITAL



Each dot represents mean adherence for an individual hospital.

FIGURE 14: RECEIVED INTRAVAENOUS THROMBOLYSIS, BY HOSPITAL (EXCLUDING TRANSFERS)

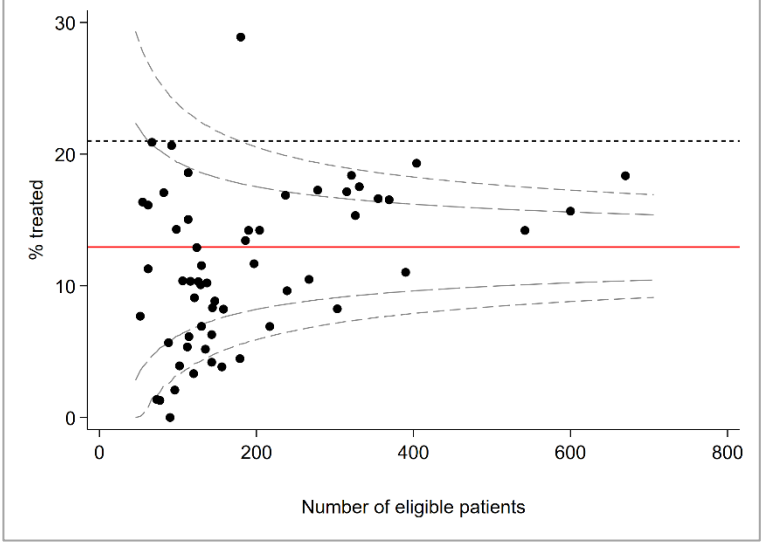


FIGURE 15: DOOR-TO-NEEDLE TIME <60 MINUTES OF ARRIVAL, BY HOSPITAL (EXCLUDING TRANSFERS)

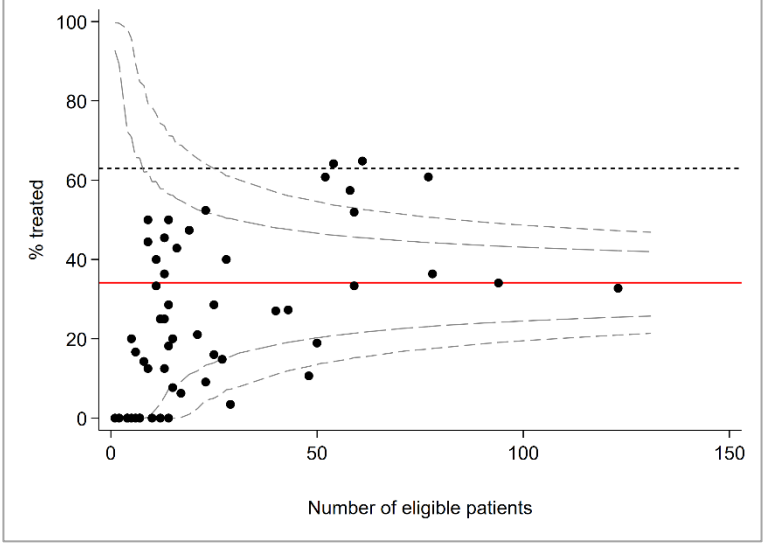
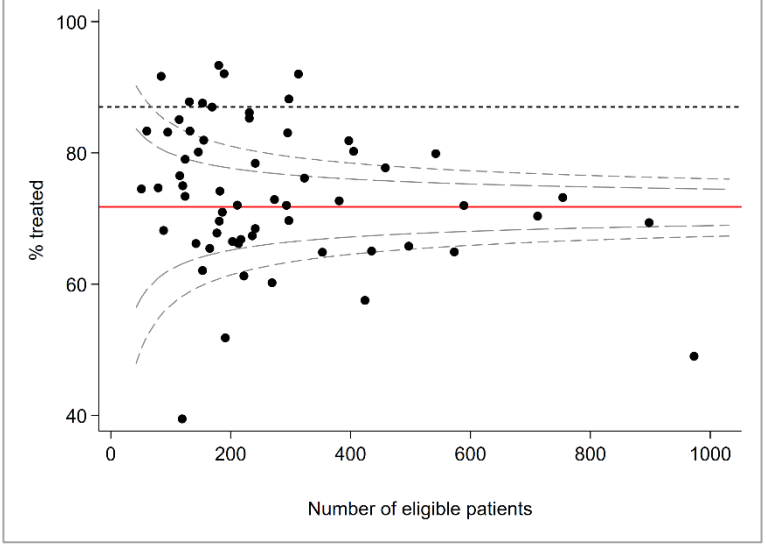


FIGURE 16: DISCHARGED ON ANTIHYPERTENSIVE MEDICATIONS, BY HOSPITAL



Each dot represents mean adherence for an individual hospital.

FIGURE 17: DISCHARGED ON ANTITHROMBOTIC MEDICATIONS, BY HOSPITAL

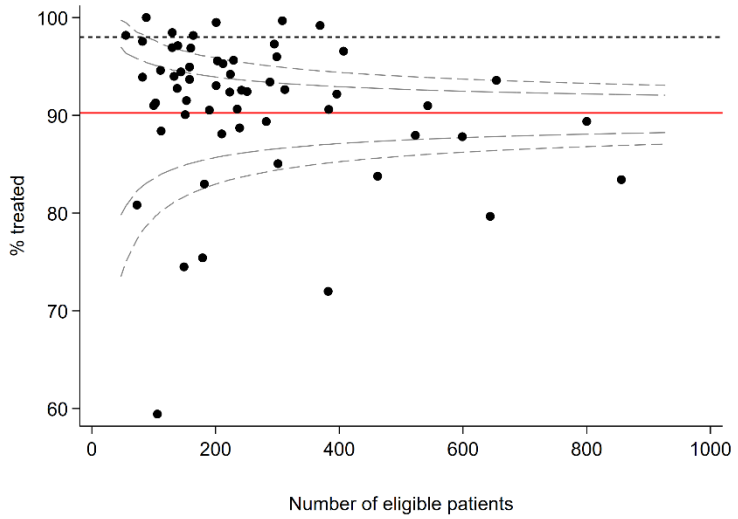


FIGURE 18: DISCHARGED ON LIPID-LOWERING MEDICATIONS, BY HOSPITAL

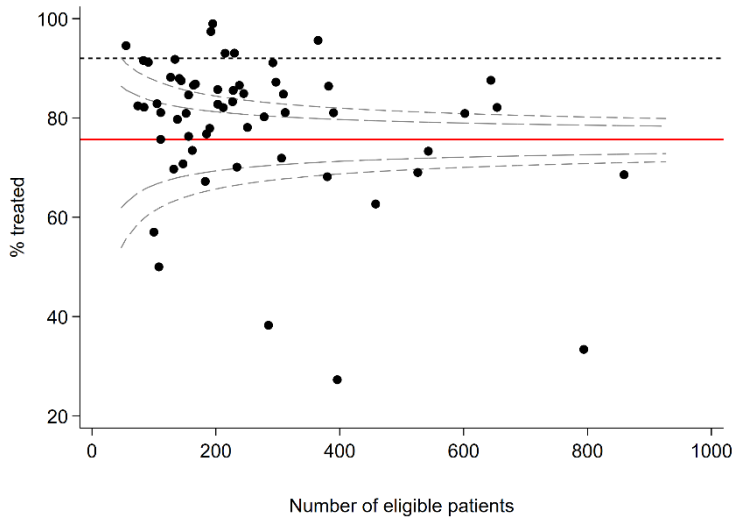
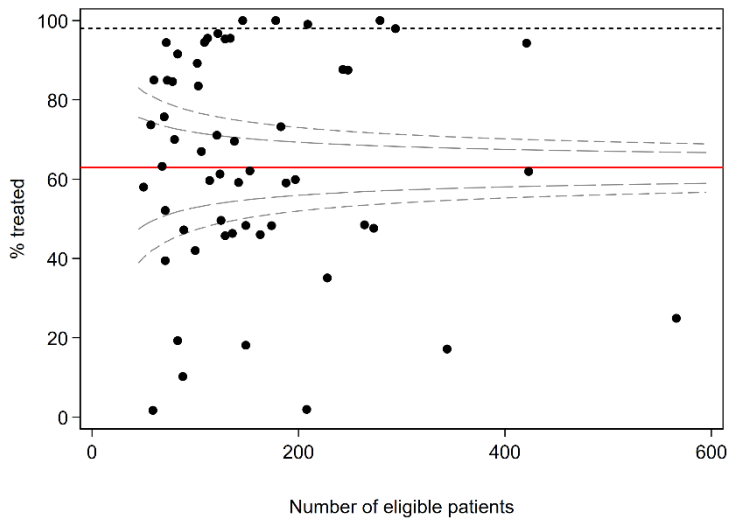


FIGURE 19: CARE PLAN PROVIDED IF DISCHARGED HOME OR TO RESIDENTIAL AGED CARE, BY HOSPITAL



Each dot represents mean adherence for an individual hospital.

TRANSFERS AND REPERFUSION THERAPIES

Reason for transfers

The reason for transfer was collected for hospitals participating in the AuSCR Black and Violet data collection programs (Figure 1). Transfer for thrombolysis was indicated for 56 patients (34 in SA; 19 VIC; 2 QLD; 1 TAS) and transfer for endovascular clot retrieval was indicated for 588 patients (294 in VIC; 153 SA; 137 QLD, 4 TAS).

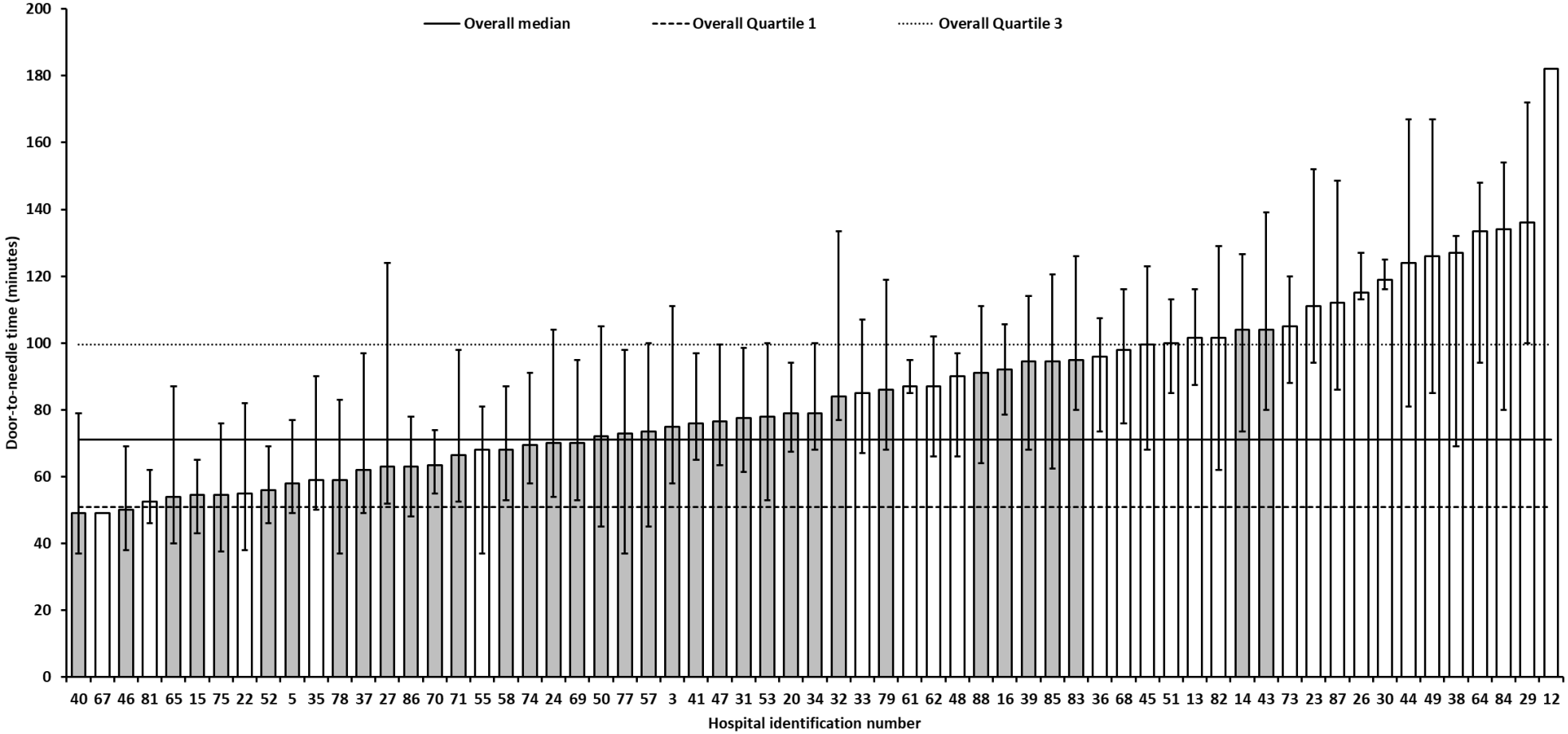
Thrombolysis treatment delivery

Of the episodes of ischaemic stroke, 1939 (14%) were provided with thrombolysis treatment. Of these, 476 episodes received thrombolysis either prior to (n=324) or following (n=152) transfer from another hospital. Overall rates of thrombolysis varied significantly by state ($p<0.001$): 18% (SA); 15% (VIC); 13% (NSW); 12% (QLD) and 7% (TAS). Thrombolysis rates were also significantly higher ($p<0.001$) in metropolitan hospitals (15%) when compared to regional hospitals (10%). Hospitals providing endovascular reperfusion therapy also had higher rates ($p<0.001$) of thrombolysis (19%) compared with hospitals who did not offer this therapy (11%).

Of the 5390 patients with ischaemic stroke arriving within 4.5 hours of symptom onset, 29% were provided with thrombolysis. For those patients with times documented, 35% had a door-to-needle time under 60 minutes, median door-to-needle time was 71 minutes and median onset-to-needle time was 153 minutes. There was no difference in the median onset-to-needle times between patients who were directly admitted and those transferred from another hospital (154 vs 153 minutes; $p=0.58$). For those provided with thrombolysis, median door-to-scan time was 19 minutes.

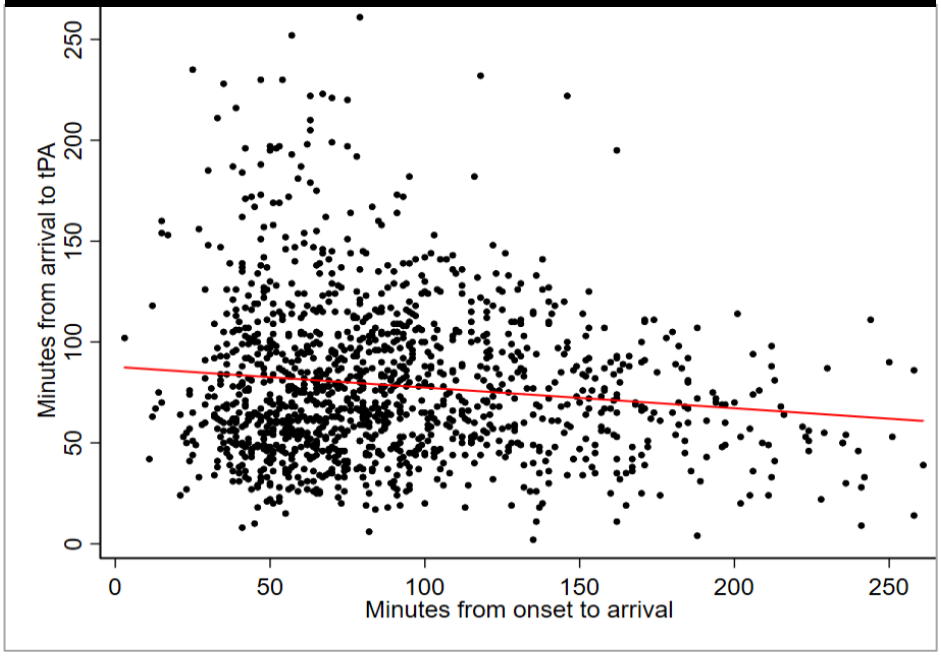
At a hospital level, 12 hospitals had a median door-to-needle time under 60 minutes (Figure 20). Patients who were treated in rural hospitals were less likely to have door-to-needle times below 60 minutes compared to patients treated at metropolitan hospitals (20% vs 39%; $p<0.001$). Furthermore, time to provision of thrombolysis was longer among patients who arrived to hospital sooner from stroke onset, compared to those arriving later (Figure 21; $p<0.001$ for trendline).

FIGURE 20: DOOR-TO-NEEDLE TIMES, BY HOSPITAL



White bars indicate hospitals contributing less than 10 episodes with door-to-needle times.
Number of episodes with door-to-needle times by hospital range from 1 to 119.
Data for episodes where door-to-needle time was greater than 270 minutes are excluded.

FIGURE 21: ONSET-TO-ARRIVAL TIME VS DOOR-TO-NEEDLE TIME



Involvement of telemedicine in acute stroke care

Telemedicine consultations were provided at 52 hospitals (10 hospitals in NSW, 17 hospitals in QLD, 1 hospital in SA, 2 hospitals in TAS and 22 hospitals in VIC). At these 52 hospitals, there were 1611 telemedicine consultations documented for adult patients, making up 10% of all episodes at these hospitals.

There were 1112 patients who had an ischaemic stroke and received a telemedicine consultation (Figure 22). Of these, 233 patients (21%) were provided with thrombolysis (Figure 23). Median door-to-needle time for these cases was 93 minutes (Q1 to Q3: 68 to 123). On average, treatment with thrombolysis was 25 minutes longer when telemedicine was used. Five hospitals had a median door-to-needle time under 60 minutes when telemedicine was used (Figure 24).

FIGURE 22: DIAGNOSIS OF PATIENTS PROVIDED WITH TELEMEDICINE CONSULTATION

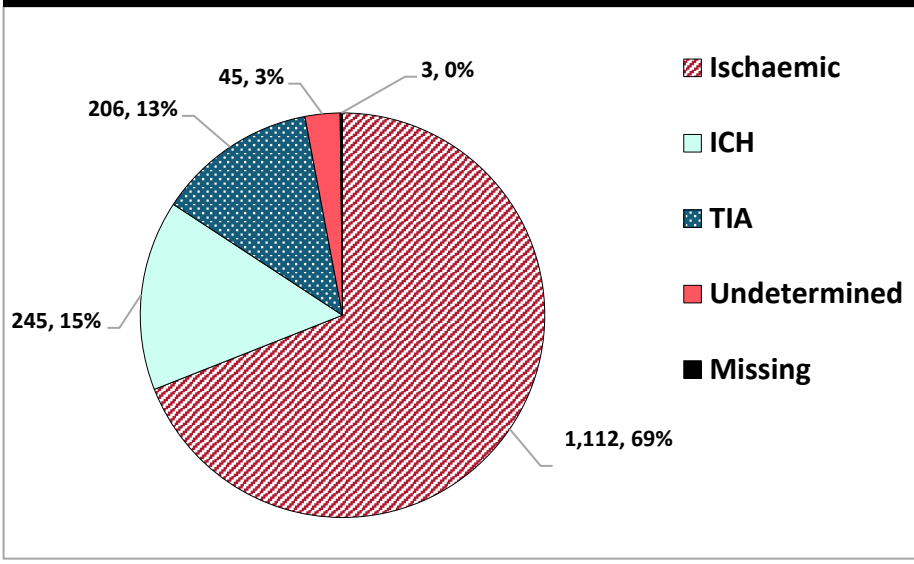


FIGURE 23: PATIENTS WITH TELEMEDICINE CONSULTATION RECEIVING THROMBOLYSIS (ISCHAEMIC STROKE ONLY)

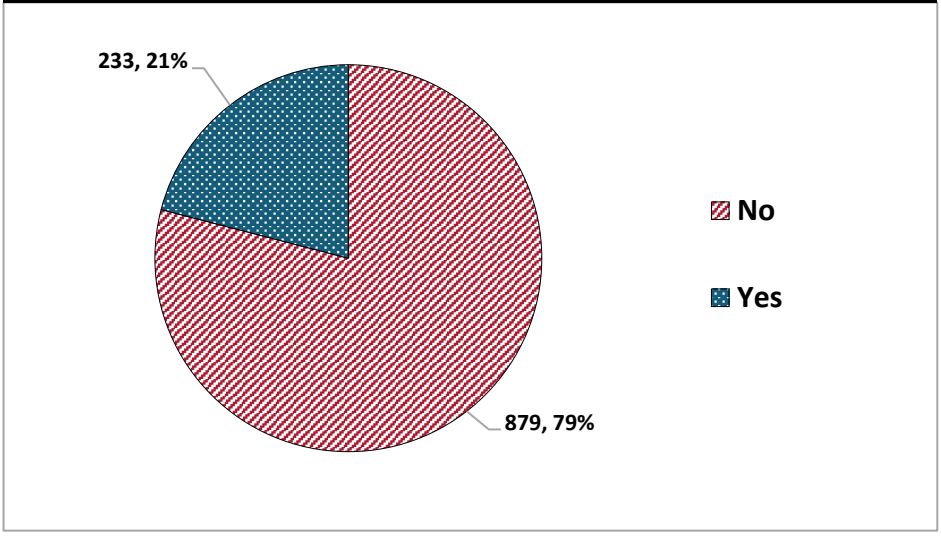
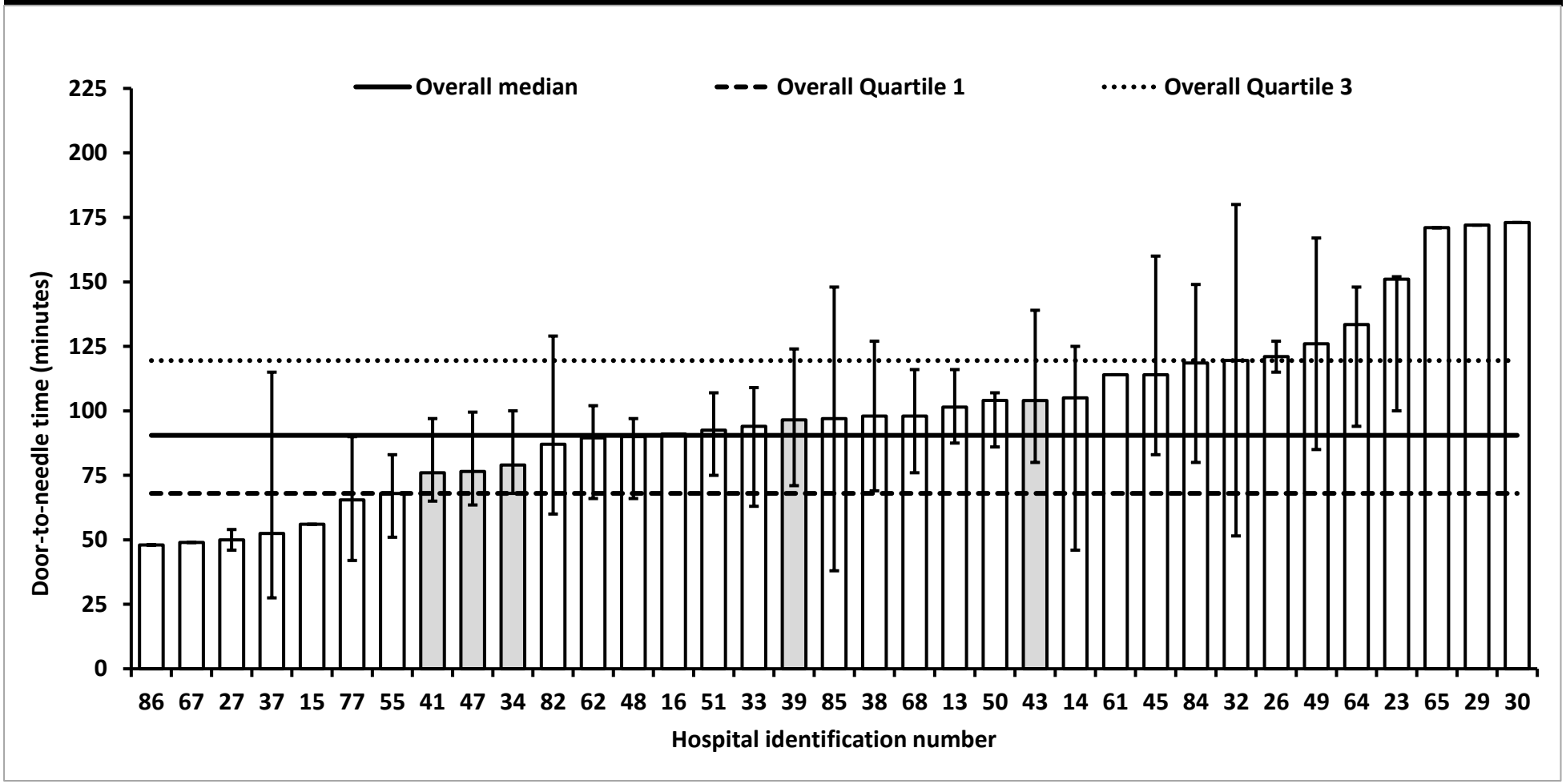


FIGURE 24: DOOR-TO-NEEDLE TIMES, BY HOSPITAL (FOR THOSE RECEIVING A TELEMEDICINE CONSULTATION)

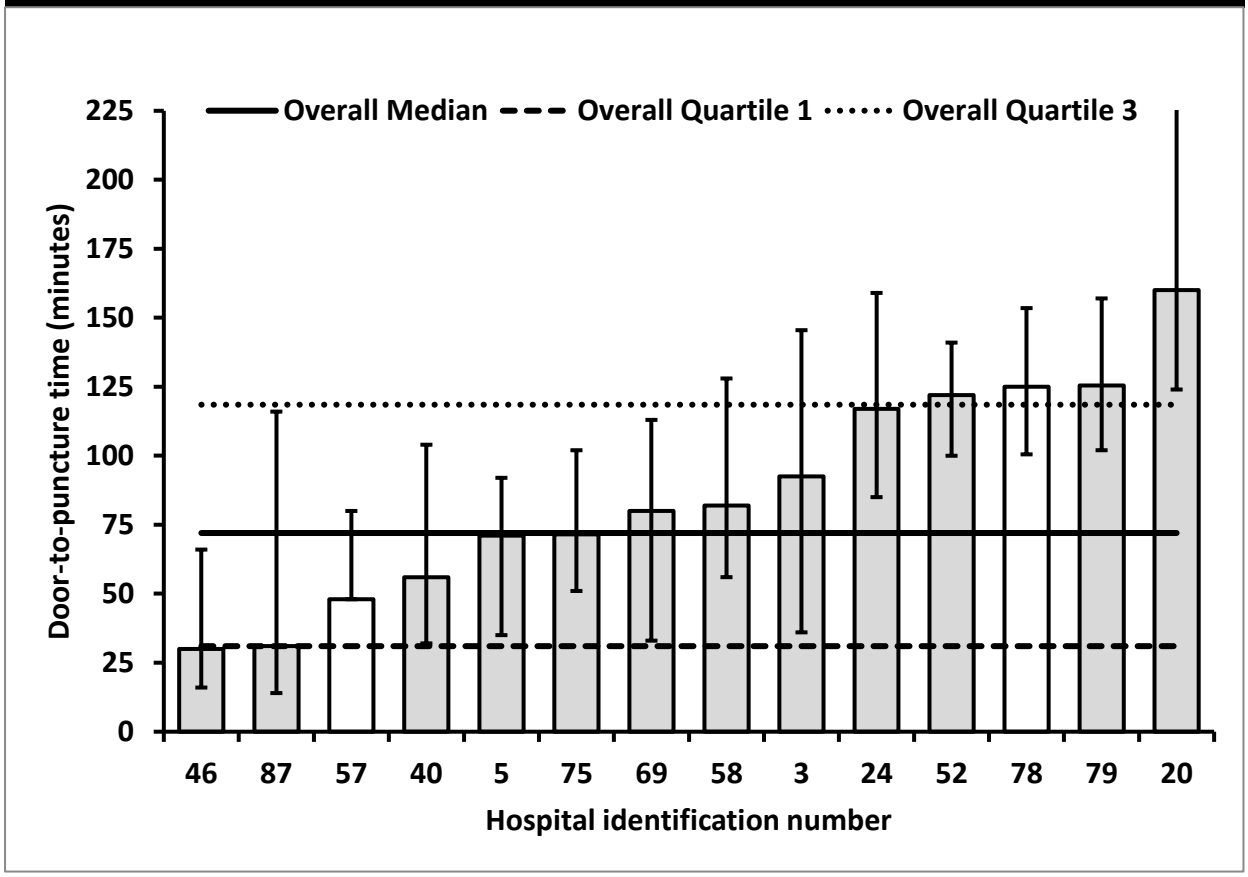


White bars indicate hospitals contributing less than 10 episodes with door-to-needle times.
Number of episodes with door-to-needle times by hospital range from 1 to 14.
Data for episodes where door-to-needle times were greater than 270 minutes are excluded, resulting in only 34 hospitals contributing data.
Note that telemedicine, consultations are provided for reasons other than the provision of intravenous thrombolysis (e.g. eligibility for ECR).

Endovascular clot retrieval (ECR)

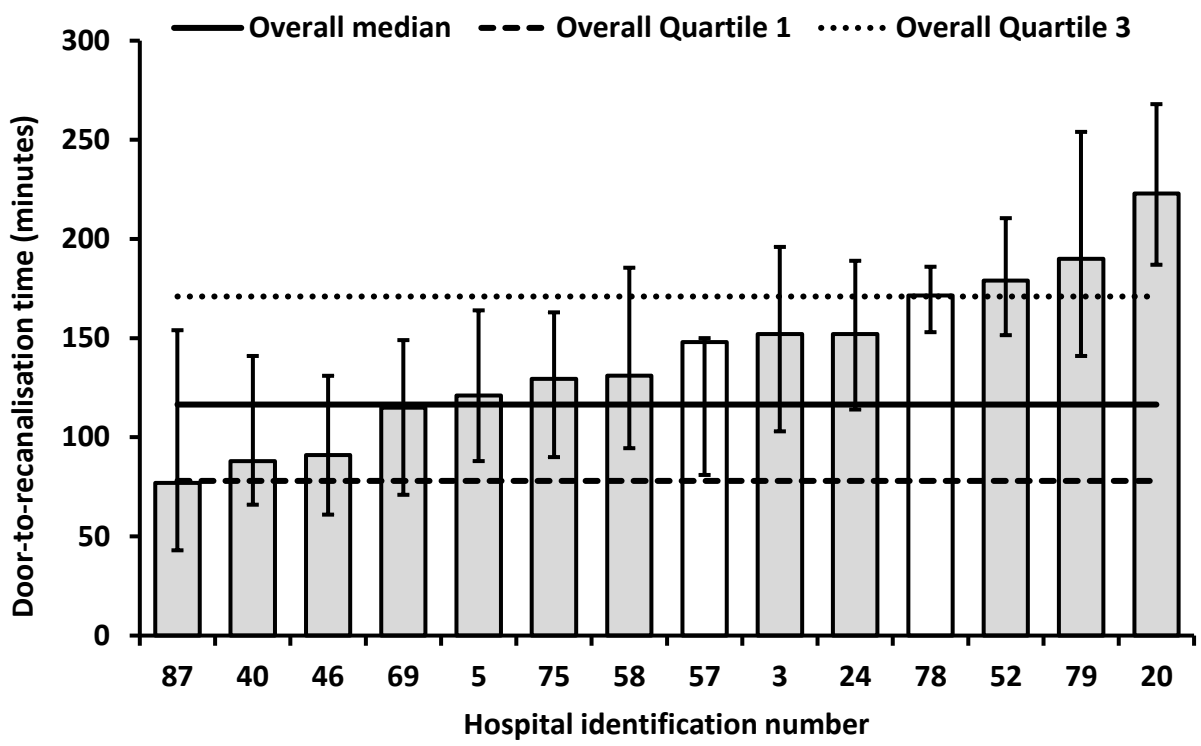
There were 1098 patients who received ECR at 15 hospitals (5 in VIC, 3 in QLD, 2 in SA, 4 in NSW and 1 in TAS). One hospital in South Australia that provided ECR to only one patient was not included in these analyses. For the episodes where times of both arrival and treatment were collected, median time from arrival to groin puncture was 72 minutes (Figure 25) and median arrival to recanalisation was 116.5 minutes (Figure 26). For patients transferred from another hospital the median onset to groin time was significantly longer at 288 minutes when compared with direct presentations (205 minutes; $p<0.001$). In contrast, for transferred patients the median time from arrival to groin puncture was 76 minutes faster when compared to direct presentations (32 minutes vs 108 minutes; $p<0.001$).

FIGURE 25: DOOR-TO-PUNCTURE TIMES FOR PATIENTS RECEIVING ECR, BY HOSPTIAL



White bars indicate hospitals contributing less than 10 episodes with door-to-puncture times.
Data for episodes where door-to-puncture time was greater than 720 minutes are excluded.
Number of episodes with door-to-puncture times by hospital range from 3 to 215.

FIGURE 26: DOOR-TO-RECANALISATION TIMES FOR PATIENTS RECEIVING ECR, BY HOSPITAL



White bars indicate hospitals contributing less than 10 episodes with door-to-recanalisation times.
Data for episodes where door-to-puncture time was greater than 720 minutes are excluded.
Number of episodes with door-to-recanalisation times by hospital range from 3 to 214.

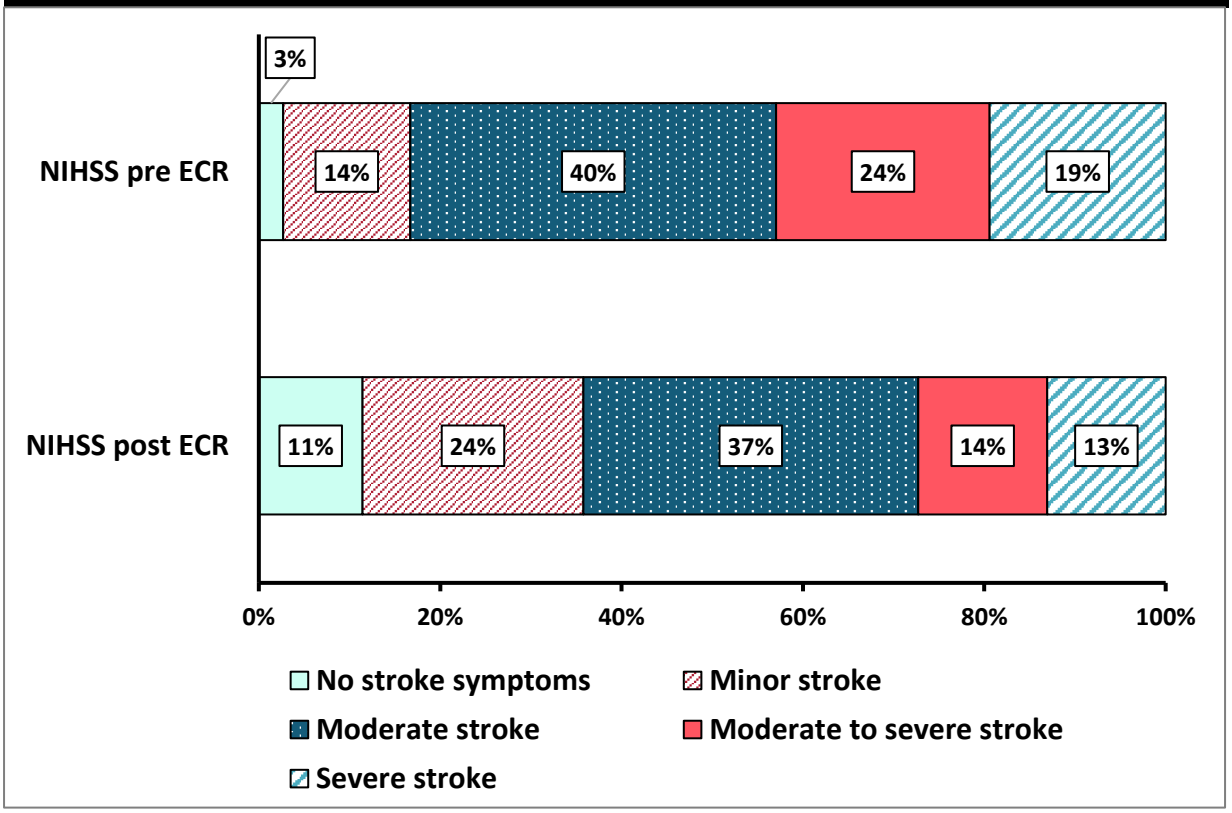
National Institutes of Health Stroke Scale Scores (NIHSS) before and after ECR

Stroke severity is able to be assessed with the NIHSS. The score is also used to assess eligibility for some treatments, as well as effects of treatments.

In addition to the NIHSS score obtained at hospital arrival, hospitals participating in the AuSCR Black or Violet Programs also collect a NIHSS score before ECR and 24 hours after ECR. Data quality for the pre- and post-ECR NIHSS variable was generally poor, with the majority being either missing or reported as unknown.

Of the 1098 cases provided with ECR, 699 had a NIHSS score pre-ECR recorded (64% complete) and 612 had a NIHSS score post-ECR recorded (56% complete). For 265 (24%) patients without a documented pre-ECR NIHSS scores, the baseline NIHSS score recorded at admission was substituted. A summary of NIHSS scores before and after ECR is given in Figure 27.

FIGURE 27: NIHSS SCORES BEFORE AND AFTER ECR



Key to NIHSS scores
0: No stroke symptoms
1-4: Minor stroke
5-15: Moderate stroke
16-20: Moderate to severe stroke
21-42: Severe stroke

DISCHARGE MEDICATIONS

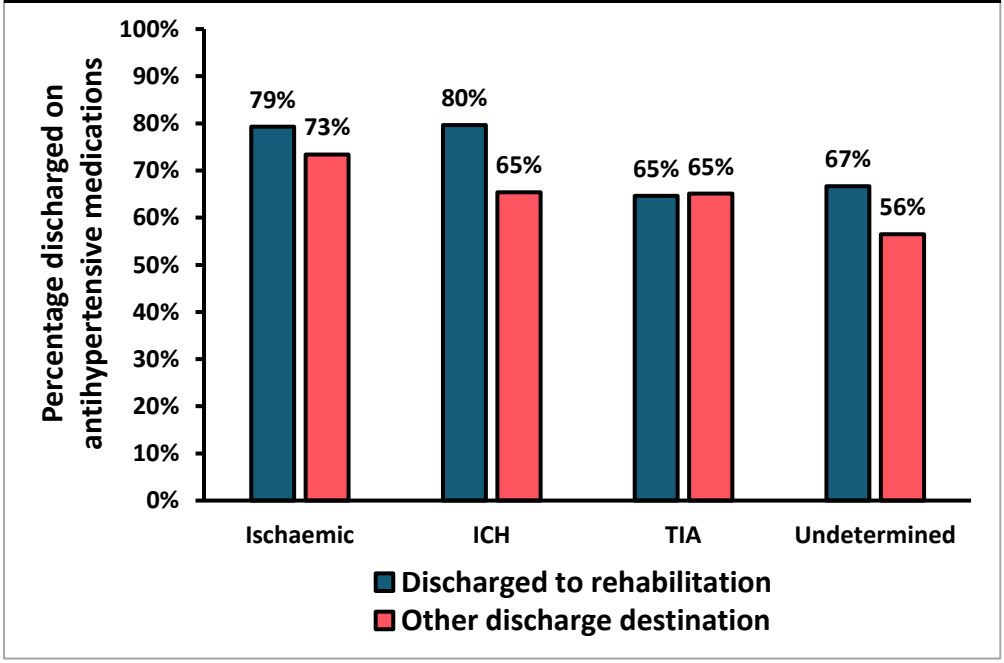
Overall, among those alive at discharge, 72% were discharged on an antihypertensive medication. In those with an ICH, 74% were discharged on an antihypertensive medication. Antithrombotic medications were prescribed at discharge for 90% of patients with ischaemic stroke or TIA, and lipid-lowering medications were prescribed for 76% of these patients at discharge (Table 7). Of the patients with ischaemic stroke, 56% were discharged on a combination of antihypertensive, antithrombotic and lipid-lowering medications. While there was no difference in age between those prescribed all three medications and those who were not, males were significantly more likely to receive all three (59% versus 53%; p<0.001) as well as those in regional areas (30% versus 26%; p<0.001). Patients who were discharged to rehabilitation more often were prescribed antihypertensive medication at discharge compared with patients discharged to other settings in all sub-types of stroke, excluding TIA (Figure 28).

TABLE 7: DISCHARGE MEDICATIONS, BY STROKE TYPE

Medication on discharge	All episodes	Ischaemic	ICH	TIA
Discharged on an antihypertensive medication*	72%	75%	74%	65%
Discharged on an antithrombotic medication*	90%	93%	*n/a*	88%
Discharged on a lipid-lowering medication*	76%	78%	*n/a*	73%
Discharged on a combination of secondary prevention medications*^	54%	56%	*n/a*	52%

**Excludes patients with contraindications*
^A combination of antihypertensive, antithrombotic and lipid-lowering medications
n/a: not applicable

FIGURE 28: PRESCRIPTION OF ANTIHYPERTENSIVE MEDICATION AT DISCHARGE



ICH: intracerebral haemorrhage
TIA: transient ischaemic attack

OUT-OF-HOURS ADMISSION AND QUALITY INDICATORS

Of the 19670 patients registered in the AuSCR with a documented time of admission, 10203 (52%) were admitted outside of the hours of 8am–6pm, Monday to Friday. Patients admitted out-of-hours were less likely to be managed in a stroke unit, receive thrombolysis within 60 minutes of arrival or receive endovascular clot retrieval when compared to those admitted between 8am and 6pm on a weekday (Table 8). Door to groin puncture times were also significantly longer for those patients admitted out of hours.

TABLE 8: OUT-OF-HOURS ADMISSION AND QUALITY INDICATORS

Process of care	Admitted 8am-6pm on a weekday	Admitted out-of-hours	p-value
Received stroke unit care	78%	74%	<0.001
Received intravenous thrombolysis if an ischaemic stroke‡	13%	12%	0.24
Door-to-needle time <60 minutes‡	41%	28%	<0.001
Received endovascular clot retrieval if an ischaemic stroke‡	23%	17%	<0.001
Median door-to-groin puncture times (Q1, Q3)	67 (31, 106)	89 (31, 133)	<0.001

‡ Benchmarks related to thrombolysis and endovascular clot retrieval exclude those who received thrombolysis or endovascular clot retrieval prior to hospital arrival (i.e. prior to transfer).

WEEKEND DISCHARGE AND QUALITY INDICATORS

Of the 17930 patients registered in the AuSCR with a documented date of discharge, 1757 (10%) were discharged on the weekend. Table 9 shows differences in quality indicators between weekday and weekend discharge.

TABLE 9: WEEKEND DISCHARGE AND QUALITY INDICATORS

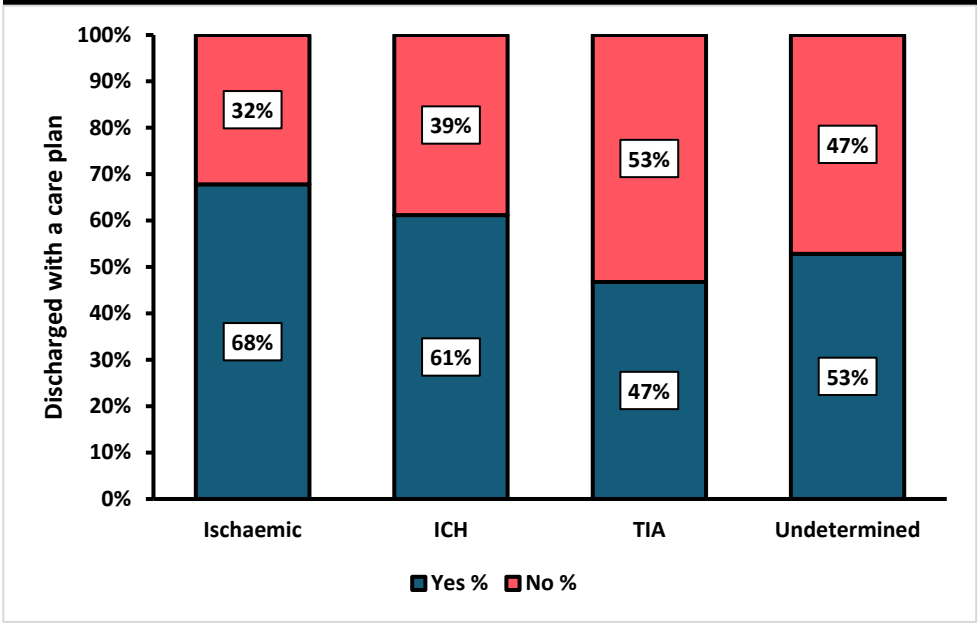
Process of care	Weekday discharge	Weekend Discharge	p-value
Received stroke unit care	78%	67%	<0.001
Discharged on antihypertensive medication^	74%	66%	<0.001
Discharged on antithrombotic medication^	92%	89%	<0.001
Discharged on lipid-lowering medication^	78%	71%	<0.001
Care plan provided if discharged to the community	64%	53%	<0.001

^ Excludes patients with contraindications

TRANSITION FROM HOSPITAL CARE

Among the 9278 episodes resulting in discharge home or to a residential aged care facility, 62% received a discharge care plan. Of the patients with ischaemic stroke, 68% were provided a care plan at discharge, compared with 61% of those with ICH, 47% of those with TIA and 53% of those with an undetermined stroke type (Figure 29).

FIGURE 29: DISCHARGED TO THE COMMUNITY WITH A CARE PLAN, BY STROKE TYPE



ICH: intracerebral haemorrhage
TIA: transient ischaemic attack

DISCHARGE INFORMATION

Hospital outcome measures include length of stay, discharge destination and discharge status. In the case where data for an individual person are segregated across two hospitals for the same stroke episode, the discharge information is reported from the first hospital providing care. Unless otherwise stated, the data presented in this section relate to the hospital that provided the initial care.

IN-HOSPITAL DEATHS

Among the 20026 adult episodes of care, 1639 (8%) patients died while in hospital. Patient mortality in hospital was 20% greater for women after adjustment for age ($p<0.001$). Case fatality was also significantly higher for ICH when compared to ischaemic, undetermined and TIA ($p<0.001$). There were two paediatric in-hospital deaths reported.

LENGTH OF STAY

Of the 18127 episodes that were discharged, 17720 had information provided on length of stay. Of these episodes, 920 (5%) stayed 21 days or more. The median length of stay was four days (Q1 to Q3: 2 to 8 days; Table 10). Patients with TIA more often had a short length of stay (less than five days) compared to patients with stroke (89% TIA, 50% stroke, $p<0.001$).

There was a statistically significant difference between the length of stay for episodes treated in stroke units (median 4 days, Q1 to Q3: 2 to 8 days) and those not treated in stroke units (median 2 days, Q1 to Q3: 1 to 6 days, $p<0.001$).

TABLE 10: MEDIAN LENGTH OF STAY

	Median length of stay in days (Q1, Q3)
All episodes	4 (2, 8)
Intracerebral haemorrhage	6 (3, 12)
Ischaemic	5 (2, 8)
Transient ischaemic attack	1 (1,3)
Undetermined	3 (1, 6)
Treated in a stroke unit	4 (2, 8)
Not treated in a stroke unit	2 (1, 6)

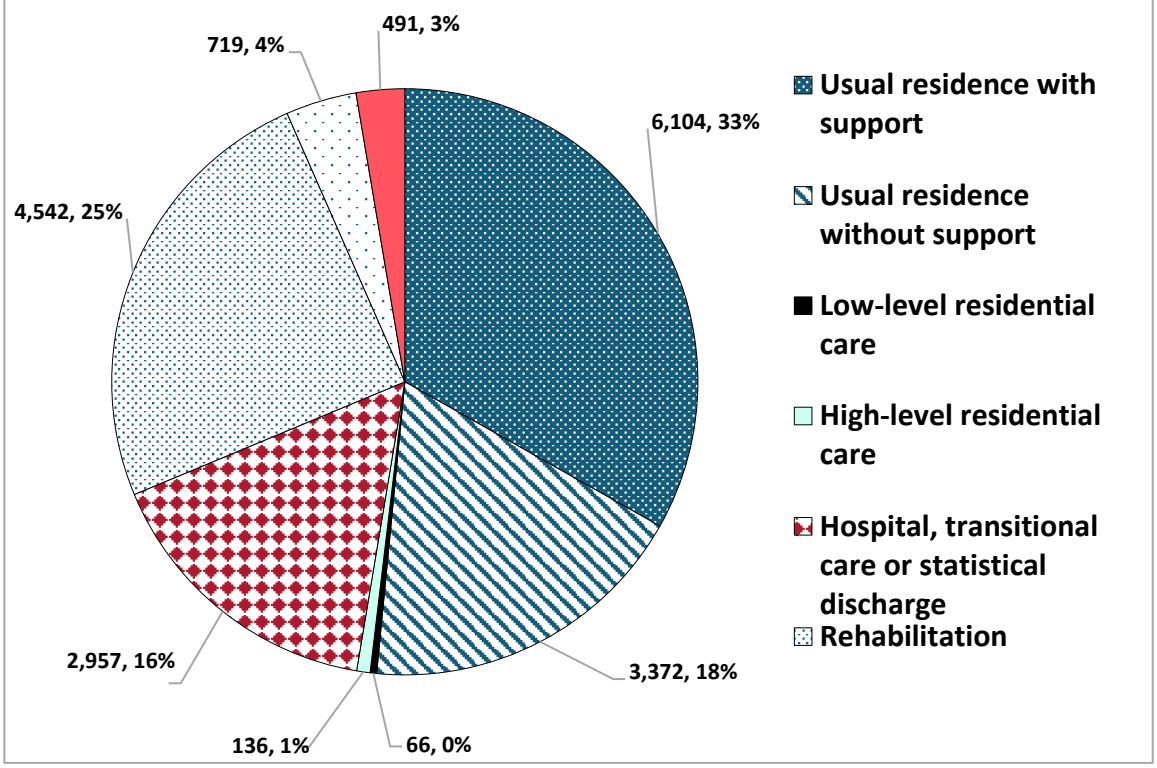
DISCHARGE DESTINATION

In 2018, excluding in-hospital deaths, approximately half of the episodes of care resulted in patients being discharged to their usual residence (n=9,476; 51%), with the majority of these patients requiring support (Figure 30). The definition of support provided within a usual residence may include regular care and assistance by health professionals, council services or volunteers including spouse or family members who may, or may not, be living in the same residence.

Patients managed in a stroke unit had a two-fold increased odds of being discharged to a rehabilitation facility compared to those patients not managed in a stroke unit (odds ratio 2.17, 95% confidence interval 1.95-2.41, p<0.001) when adjusted for age, sex, type of stroke, ability to walk on admission, inpatient or community-onset stroke, and whether or not the patient was transferred from another hospital. Patients treated in a stroke unit were more often discharged to inpatient rehabilitation regardless of whether or not they were able to walk on admission (33% vs 16% unable to walk on admission, p<0.001 ; 18% vs 8% able to walk on admission, p<0.001).

Most patients with TIA (88%, n=2,452) were discharged to a home setting, 2% (n=67) went to rehabilitation and the remainder went to aged care, transitional care services or other hospitals. It is unclear whether these patients had already been in aged care prior to this event or had other co-morbidities, or complications while in hospital, which may have influenced their discharge destination. Of the 24 registrants with TIA who were discharged to residential aged care, 13% had a documented history of a previous stroke.

FIGURE 30: DISCHARGE DESTINATION, INCLUDING MULTIPLE EPISODES



n=18,387 episodes
Excludes paediatric cases and episodes of care resulting in death while in hospital

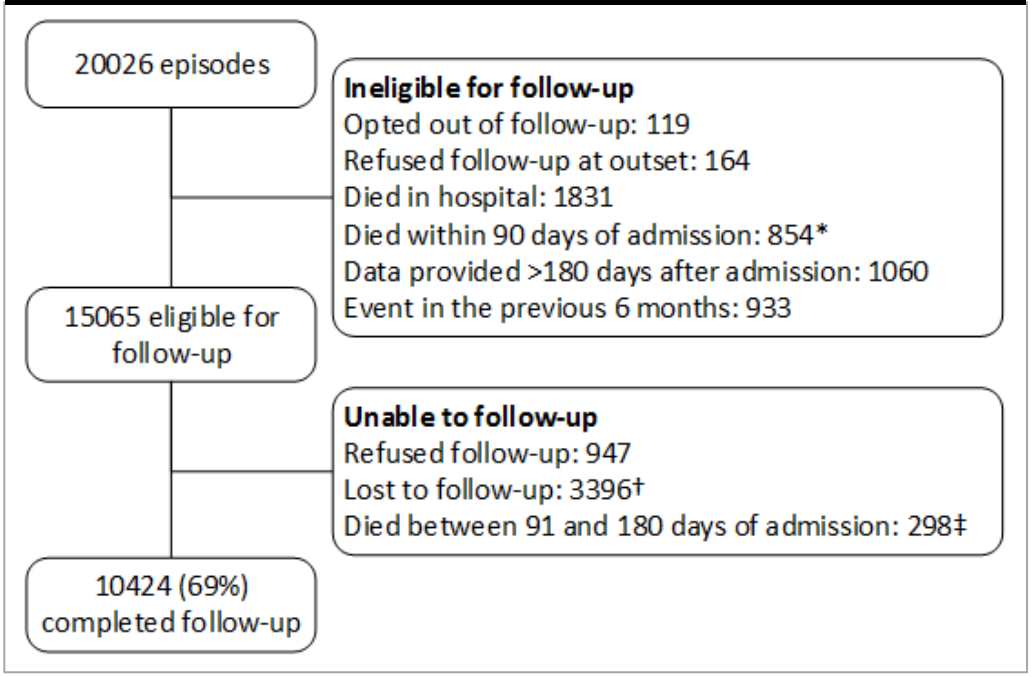
POST-DISCHARGE HEALTH OUTCOME INFORMATION

RESPONSE RATES

Of the 15065 adult episodes eligible for a follow-up survey, 10424 (69%) of patients or their proxy provided information about their health status (Figure 31). Median time to follow-up was 144 days from stroke admission date (Q1 to Q3: 108 to 185 days).

There were 25 episodes occurring in patients under the age of 18. Of these, 14 were admitted to a children's hospital and 11 were admitted to adult hospitals. Two of these patients died prior to follow-up at 90-180 days following admission and nine of these patients, or their proxies, completed follow-up. Four patients were aged between one and 12 years, and five were aged between 13 and 18 years.

FIGURE 31: FOLLOW-UP OF PATIENT EPISODES IN 2018 (EXCLUDING PAEDIATRIC EPISODES)



* *Deaths after discharge and within 90 days of admission were determined using the NDI.*

† *Contact unable to be made using our follow-up protocol (two postal attempts and one telephone attempt)*

‡ *Deaths between 91 and 180 days of admission were determined using the NDI. Note that this figure does not represent total deaths between 91-180 days following admission for a variety of reasons including: patient completed follow-up, lost to follow-up, data provided >180 days after admission, refused follow-up, and opted out.*

FOLLOW-UP DATA

Of the patients eligible for follow-up, differences were identified in both demographic and clinical characteristics, as well as in processes of care which are the basis of our quality indicators (Table 11).

At follow-up, approximately one in four registrants reported hospital readmissions (Table 12). Most registrants who were followed up were living at home (85%), while 24% of registrants were living alone. There were 1135 (11%) registrants living in low level care or high level care for whom information at follow-up was obtained. Twenty four percent of registrants completing follow-up were free from disability, reporting no symptoms at all on the modified Rankin Scale (44% TIA; 27% undetermined; 21% ischaemic and 14% ICH).

Of the 1098 patients who received endovascular clot retrieval 894 (81%) were alive at 180 days post admission. Of these, 565 (63%) completed the mRS (Figure 32).

TABLE 11: CHARACTERISTICS OF PATIENTS WITH AND WITHOUT POST DISCHARGE INFORMATION

	Completed (n=10424)	Not completed (n=4641)	*p* value
Age (years), mean (SD)	73 (13)	70 (15)	<0.001
Female, n (%)	4419 (43)	2019 (45)	0.037
Aboriginal and/or Torres Strait Islander, n (%)	155 (2)	157 (4)	<0.001
Type of stroke, n (%) *Ischaemic* *Intracerebral haemorrhage* *Transient ischaemic attack* *Undetermined*	 7501 (72) 941 (9) 1677 (16) 240 (2)	 3249 (71) 473 (10) 732 (16) 118 (3)	0.062
Able to walk on admission, n (%)	5328 (55)	2011 (48)	<0.001
Length of hospital admission (days), median (Q1 to Q3)	4 (2 to 7)	5 (2 to 9)	<0.001
Treated in a stroke unit, n (%)	8220 (79)	3467 (76)	<0.001

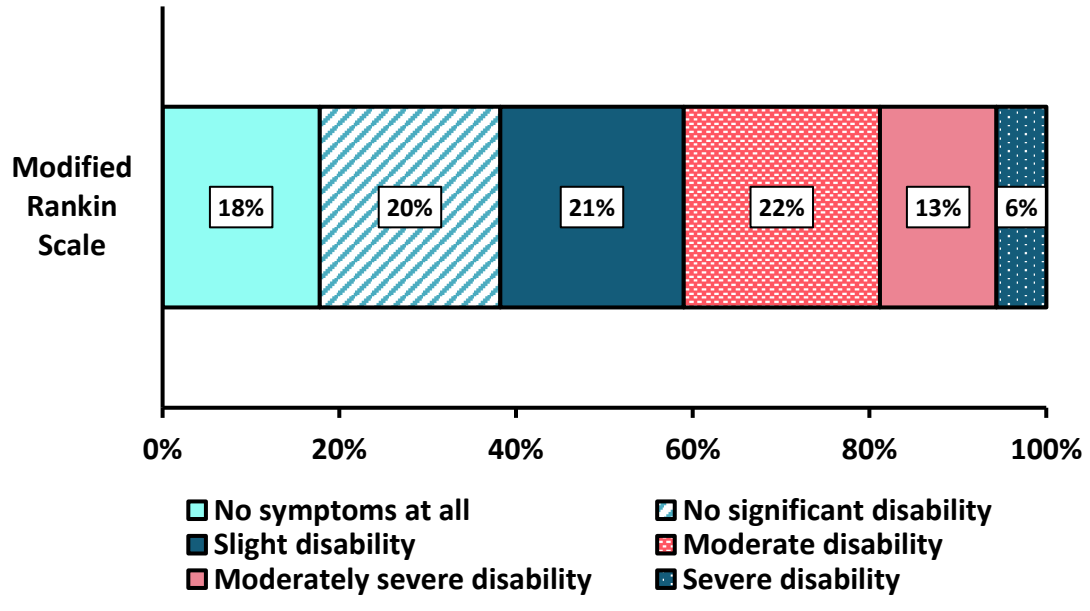
Excludes paediatric episodes
SD: standard deviation
Q1: 25th percentile
Q3: 75th percentile

TABLE 12: INFORMATION OBTAINED AT FOLLOW-UP

	Number reported (%)
Had a recurrent stroke	**425 (4%)**
Readmitted to hospital	2343 (23%)
Location at time of follow-up interview	
Home	8819 (85%)
Living alone	2088 (24%)
Living with others	6675 (76%)
With care support	4168 (47%)
Without care support	4651 (53%)
Institutional care or other setting	1511 (15%)
In hospital	109 (1%)
Transitional care services	95 (1%)
Low level care (hostel care)	83 (1%)
High level care (nursing home)	1052 (10%)
Inpatient rehabilitation	97 (1%)
Other	75 (1%)
Modified Rankin Scale	
0 – No symptoms at all	2536 (24%)
1 – No significant disability despite symptoms	2302 (22%)
2 – Slight disability	1888 (18%)
3 – Moderate disability	2175 (21%)
4 – Moderately severe disability	1051 (10%)
5 – Severe disability	401 (4%)
Missing	71 (1%)

Missing data not included in denominators
Excludes paediatric episodes

FIGURE 32: MODIFIED RANKIN SCALE SCORES AT FOLLOW-UP, FOR PATIENTS RECEIVING ECR



HEALTH-RELATED QUALITY OF LIFE

With respect to health-related quality of life, patients with ICH reported problems in all dimensions of the EQ-5D-3L more commonly than the other diagnoses (Table 13). Problems in relation to usual activities were most common in all subtypes apart from TIA, in which problems were most commonly reported in relation to the pain/discomfort and usual activities dimensions (45% of respondents). Problems in relation to anxiety and depression were reported most commonly in patients with ICH (54% of respondents). The mean Visual Analogue Scale (VAS) score, which represents self-reported overall health (min 0, max 100) was greatest in patients with TIA (72) and least in patients with ICH or undetermined stroke (65). In patients with ischaemic stroke, the mean VAS was 68. These VAS scores should be considered in relation to a mean of 83 for the normative population of adults in the United Kingdom.[10]

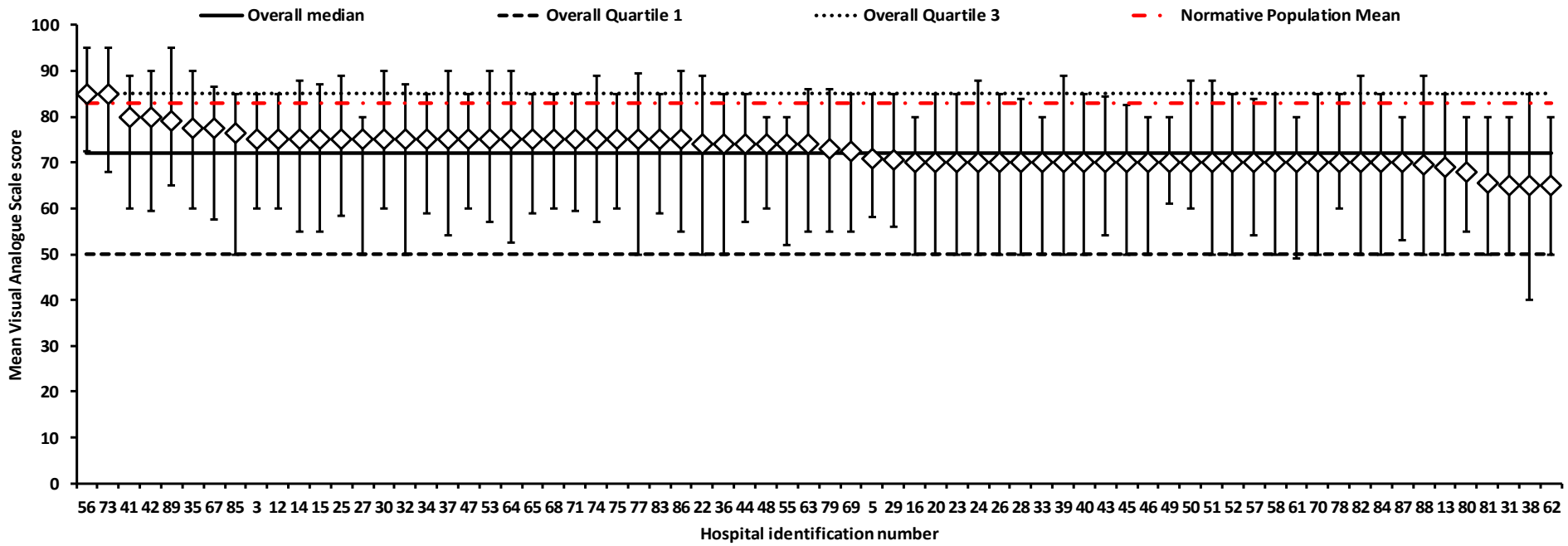
TABLE 13: QUALITY OF LIFE ASSESSMENT AMONG SURVEY RESPONDENTS, STRATIFIED BY STROKE TYPE

	Ischaemic N=7501	ICH N=941	TIA N=1677	Undetermined N=240	All N=10424
Proportion of patients reporting problems with EQ-5D-3L dimensions					
Mobility	50%	58%	40%	55%	49%
Self-care	31%	43%	19%	34%	30%
Usual activities	59%	69%	43%	59%	58%
Pain/Discomfort	49%	56%	43%	51%	48%
Anxiety/Depression	47%	54%	38%	50%	46%
VAS mean (SD)	68 (22)	65 (23)	72 (20)	65 (23)	68 (22)
VAS median (Q1-Q3)	71 (50-85)	69 (50-80)	75 (60-88)	70 (50-80)	72 (50-85)
Modified Rankin Scale					
0 – No symptoms at all	21%	15%	44%	27%	24%
1 – No significant disability despite symptoms	23%	19%	21%	16%	22%
2 – Slight disability	19%	18%	14%	23%	18%
3 – Moderate disability	22%	26%	15%	17%	21%
4 – Moderately severe disability	10%	16%	5%	13%	10%
5 – Severe disability	4%	7%	1%	5%	4%
Missing	1%	1%	0%	0%	1%

ICH: intracerebral haemorrhage
TIA: transient ischaemic attack
Excludes paediatric episodes
SD: standard deviation
Q1: 25th percentile; Q3: 75th percentile

Figure 33 shows the unadjusted VAS scores of patients at follow-up, by individual hospital. After adjustment for differences in patient characteristics, there was evidence of some variation in VAS scores between hospitals (Figure 34). The proportion of patients with VAS scores above the national median differed between the best and worst hospitals by more than 16 points.

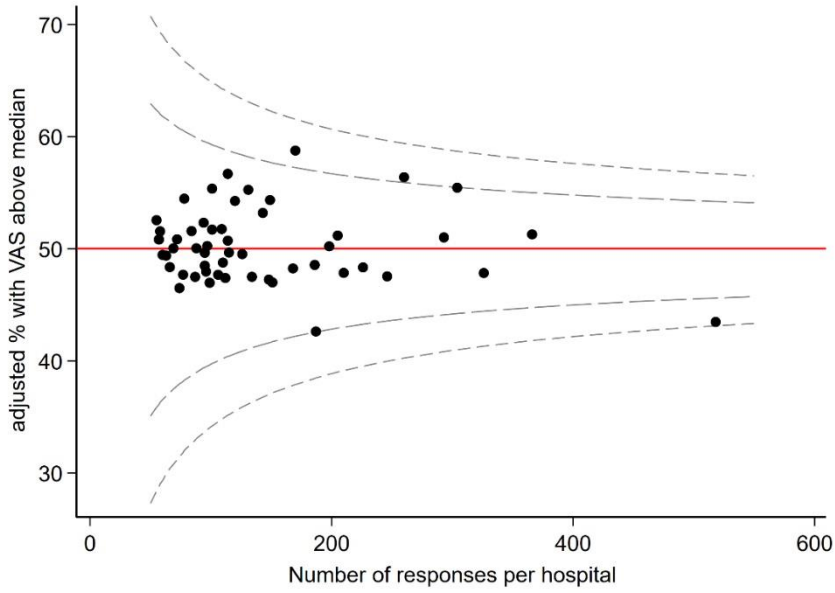
FIGURE 33: HEALTH-RELATED QUALITY OF LIFE SCORES ACCORDING TO THE VISUAL ANALOGUE SCALE AT FOLLOW-UP, BY HOSPITAL



Hospitals with fewer than 10 episodes with completed follow-up were excluded.
Mean of 83 for the normative adult population was obtained from the United Kingdom.[9]

Each dot represents the average score for patients treated at an individual hospital.

FIGURE 34: VARIABILITY IN VAS SCORES BETWEEN HOSPITALS AFTER ADJUSTMENT



Hospitals with fewer than 50 episodes providing a VAS score at follow-up were excluded.

Model was adjusted for age, sex, stroke type, ability to walk on admission and previous history of stroke.

Excludes hospitals with <10 patients who completed follow-up.

In Figures 35 to 39, the proportion of patients reporting problems to each domain of the EQ-5D-3L is displayed, after adjustment for differences in patient characteristics. Significant differences in the proportion of patients reporting problems were observed across all domains of the EQ-5D-3L, apart from anxiety/depression.

FIGURE 35: ADJUSTED PROPORTION OF PATIENTS REPORTING PROBLEMS WITH MOBILITY AT FOLLOW-UP, BY HOSPITAL

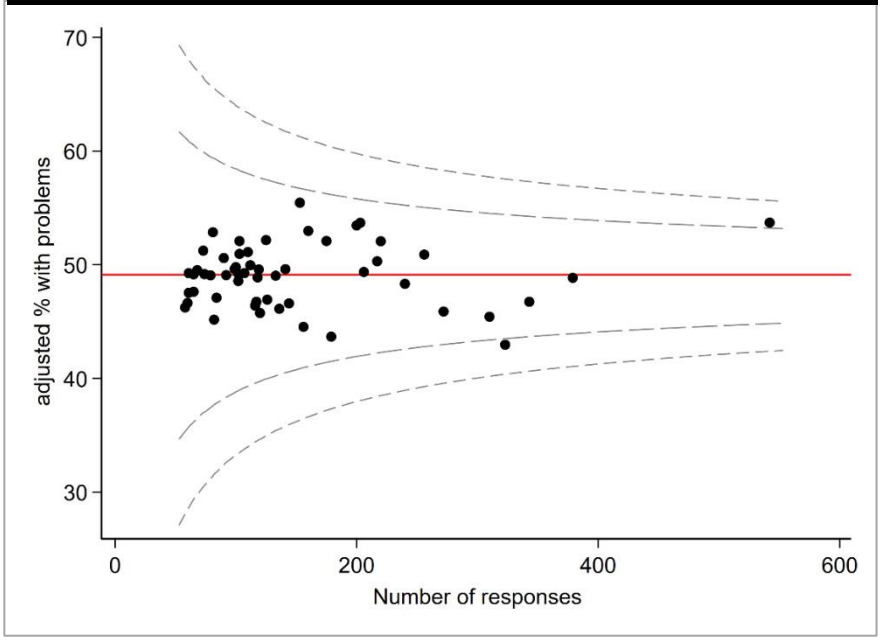
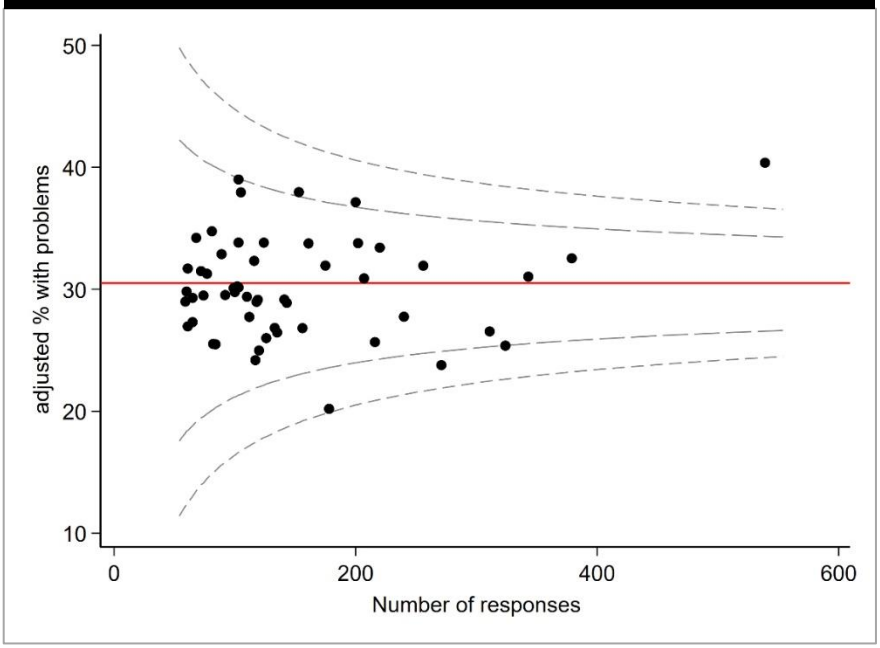


FIGURE 36: ADJUSTED PROPORTION OF PATIENTS REPORTING PROBLEMS WITH SELF-CARE AT FOLLOW-UP, BY HOSPITAL



Each dot represents the average score for patients treated at an individual hospital.

FIGURE 37: ADJUSTED PROPORTION OF PATIENTS REPORTING PROBLEMS WITH USUAL ACTIVITIES AT FOLLOW-UP, BY HOSPITAL

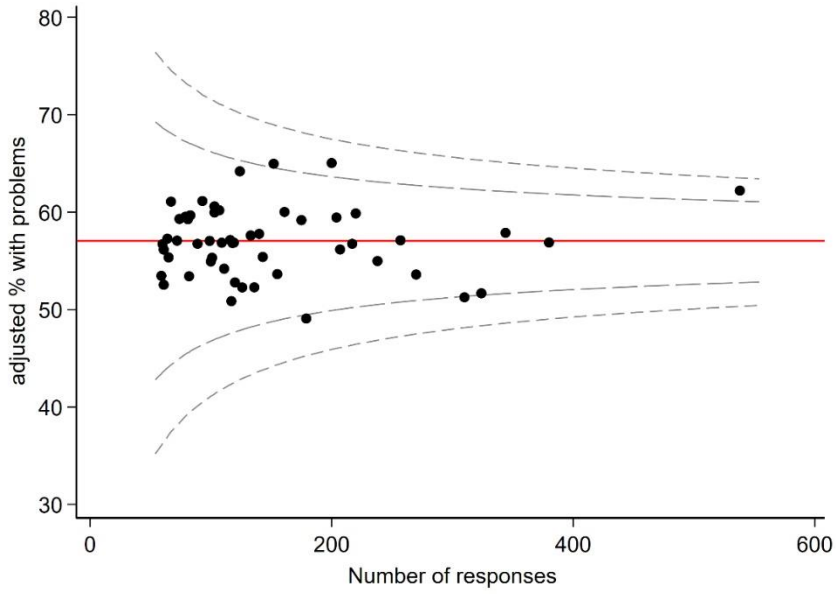
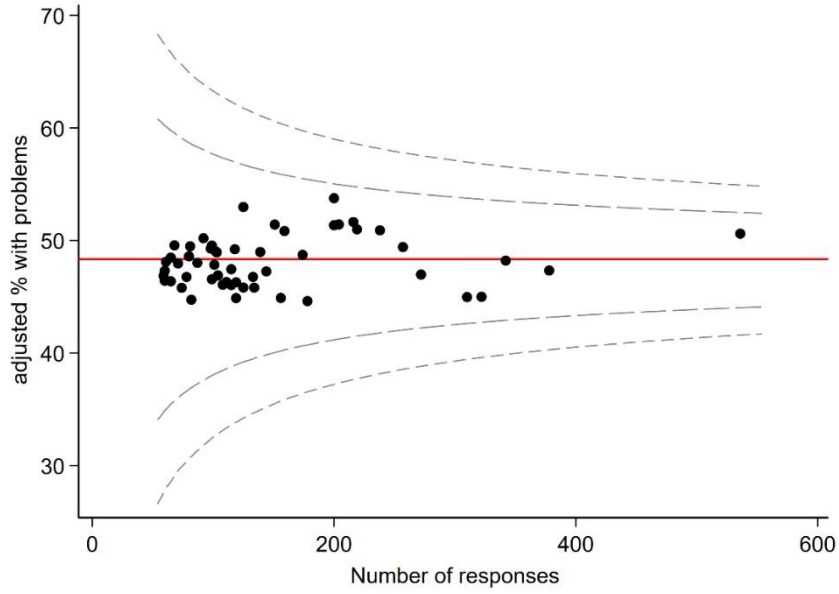
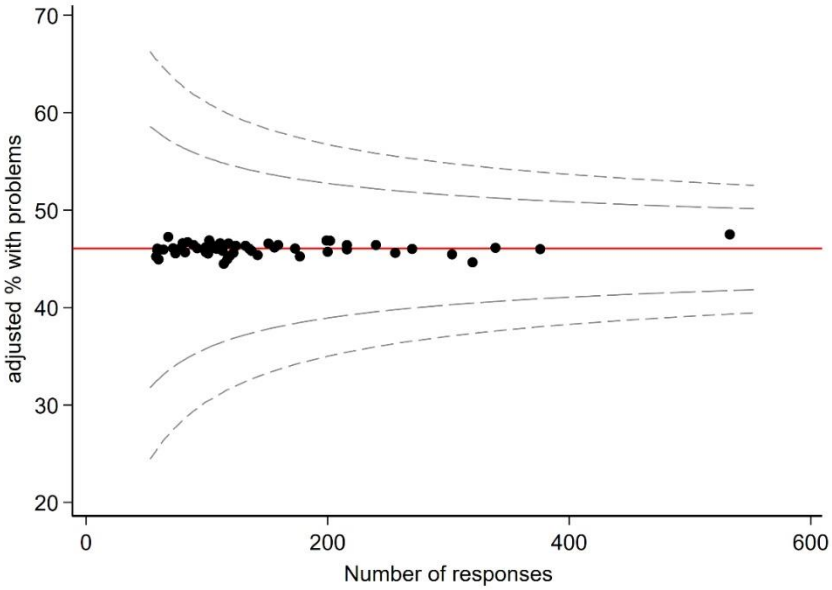


FIGURE 38: ADJUSTED PROPORTION OF PATIENTS REPORTING PROBLEMS WITH PAIN OR DISCOMFORT AT FOLLOW-UP, BY HOSPITAL



Each dot represents the average score for patients treated at an individual hospital.

FIGURE 39: ADJUSTED PROPORTION OF PATIENTS REPORTING PROBLEMS WITH ANXIETY OR DEPRESSION AT FOLLOW-UP, BY HOSPITAL



Each dot represents the average score for patients treated at an individual hospital.

PARTICIPATION IN RESEARCH

Among the 10144 registrants who answered the question about whether they would be willing to be contacted to participate in future research, 6411 (63%) replied affirmatively. Compared to those who did not reply in the affirmative, these patients were younger (median age 72 vs 78 years, $p<0.001$) and more often male (60% vs 52%, $p<0.001$).

UNMET INFORMATION NEEDS

Stroke can be a devastating and life changing event for people and there is a possibility that stroke survivors and their care providers have unmet care and information needs. Given that the AuSCR protocol includes a follow-up survey with survivors at 90-180 days post stroke or TIA, it presents an opportunity to ask registrants whether they would like to receive further information about stroke from the Stroke Foundation. In 2018, 49% (n=4946) of the 10150 registrants who answered this question, indicated that they would like to receive such information.

SURVIVAL

According to the data we were able to link with the National Death Index, there were 874 patients (4%) who died after discharge from hospital, but within 90 days of their admission, and 383 patients (2%) who died between 91 and 180 days of their admission. In patients with ischaemic stroke, treatment in a stroke unit was associated with a 41% lower hazard of death at 180 days after admission than treatment on an alternate ward (hazard ratio 0.59, 95% confidence interval 0.53-0.66, p<0.001, Figure 40). A similar result was found for patients with ICH (hazard ratio 0.40, 95% confidence interval 0.34-0.47, p<0.001, Figure 41). These analyses were adjusted for age, sex, ability to walk on admission, in-hospital stroke and transfer from another hospital.

FIGURE 40: CUMULATIVE HAZARD OF DEATH, BY TREATMENT IN A STROKE UNIT (ISCHAEMIC STROKE)

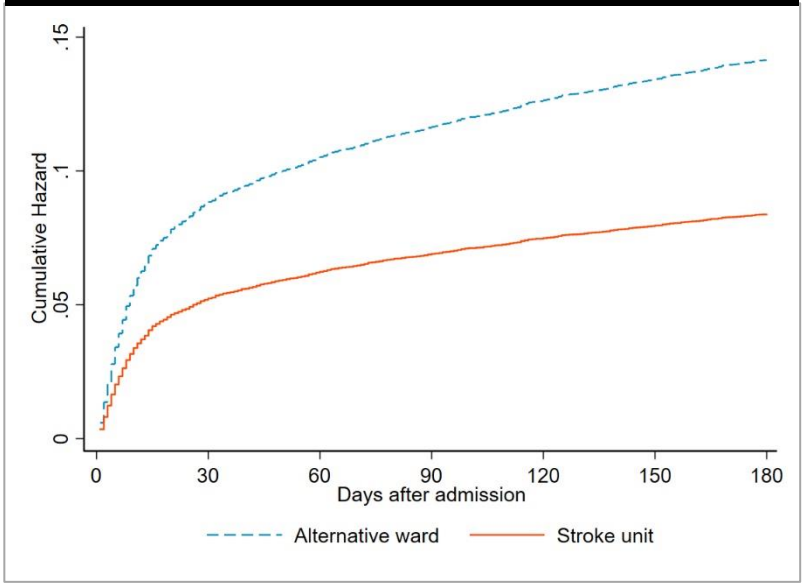
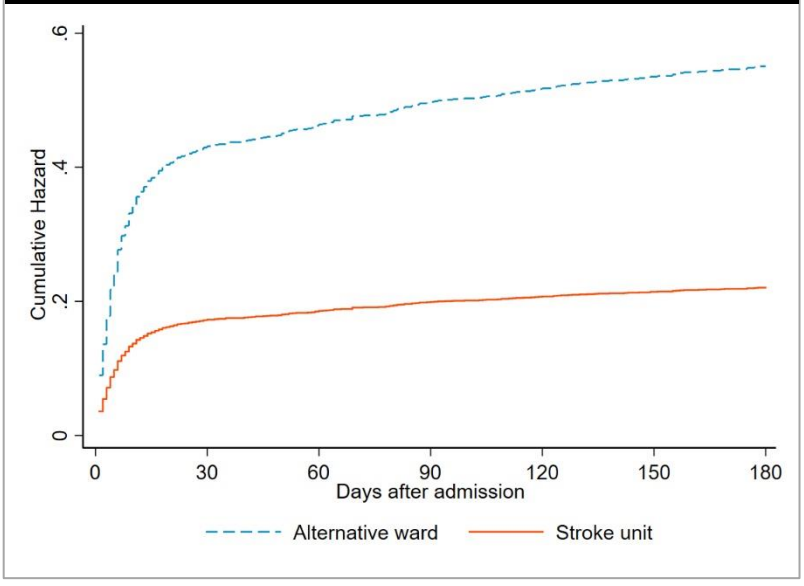


FIGURE 41: CUMULATIVE HAZARD OF DEATH, BY TREATMENT IN A STROKE UNIT (INTRACEREBRAL HAEMORRHAGE)

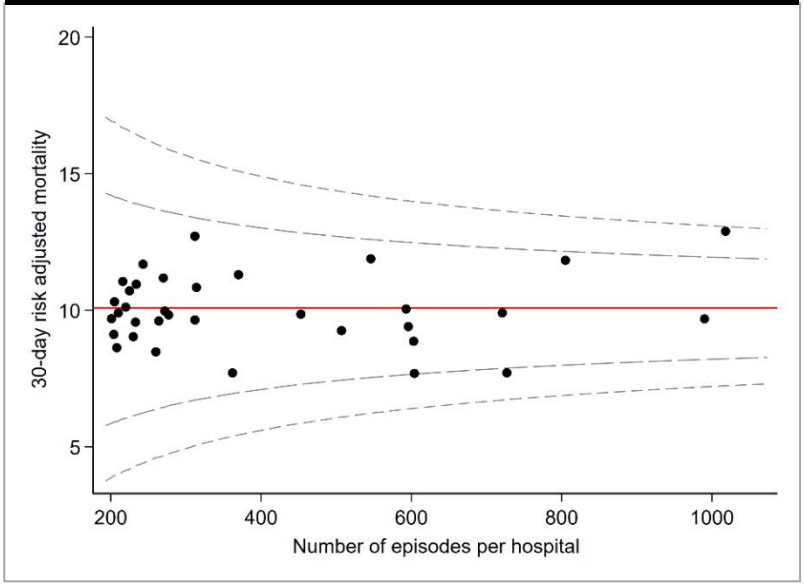


RISK ADJUSTED MORTALITY

The combined 2017 and 2018 data provided evidence of some variation in mortality after stroke between hospitals (Figures 42 and 43). These estimates may be affected by data quality and confounding factors (provision of evidence-based therapies and unmeasured variables).

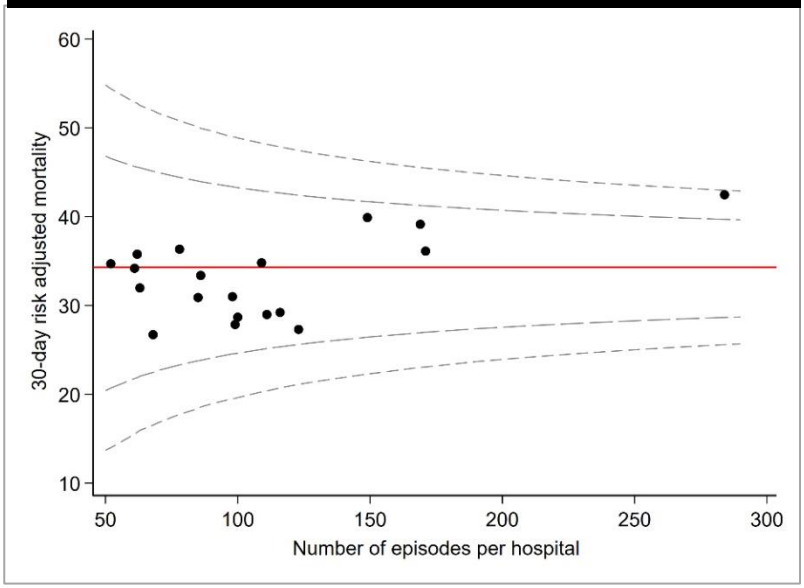
The models were adjusted for age, sex, stroke type, ability to walk on admission and previous history of stroke.

FIGURE 42: RISK ADJUSTED MORTALITY AT 30 DAYS AFTER ADMISSION FOR ISCHAEMIC STROKE, BY HOSPITAL (2017 AND 2018)



Excludes hospitals with less than 200 episodes

FIGURE 43: RISK ADJUSTED MORTALITY AT 30 DAYS AFTER ADMISSION FOR ICH, BY HOSPITAL (2017 AND 2018)



Excludes hospitals with less than 50 episodes

Each dot represents the mean risk adjusted mortality for an individual hospital.

DATA QUALITY

A full report on the quality of the AuSCR data is available in the AuSCR 2018 Data Quality Report, which is available at https://auscr.com.au/about/annual-reports. The overall case ascertainment rate was 83% (range 42-100%). Forty-three (61%) of hospitals provided 12 months of data to enable case ascertainment calculations whilst 56 (79%) provided only six months of data. Significant differences in the numbers of hospitals participating in case ascertainment were noted by state with 82% of QLD hospitals, 61% of VIC hospitals, 60% of NSW hospitals, 33% of TAS hospitals and no SA hospitals participating.

A summary of missing data for variables relating to quality indicators and casemix adjustment is presented in Table 14. Overall, the majority of variables had a better completion in 2018 when reviewed against data received in 2017. These improvements were most evident in relation to discharge on lipid-lowering medication (9% improvement) and discharge on antithrombotic medication (7% improvement) and NIHSS score on admission (6%). However, while the rate of missing NIHSS scores has improved, there was still 47% of NIHSS scores that were listed as 'unknown'.

TABLE 14: MISSING DATA FOR SELECTED AUSCR VARIABLES

Variable	% unknown 2018	% missing 2018	% unknown 2017	% missing 2017	% missing 2016
Date of birth	-	0%	-	1%	1%
Gender	-	0%	-	2%	0%
Type of stroke	-	1%	-	7%	9%
Able to walk on admission	5%	2%	5%	6%	9%
NIHSS score on admission (baseline NIHSS)	47%	3%	58%	9%	11%
Treated in a stroke unit	<1%	1%	<1%	5%	7%
Provision of thrombolysis	<1%	0%	<1%	2%	3%
Discharged on antihypertensive medication+	5%	1%	4%	6%	8%
Discharged on antithrombotic medication+	3%	1%	3%	8%	15%
Discharged on lipid-lowering medication	4%	1%	3%	10%	18%
Evidence of care plan on discharge if discharged to community	4%	2%	5%	6%	4%
Principal diagnosis (discharge diagnosis) ICD-10 code	-	5%	-	6%	4%

Excludes registrants who opted out of the AuSCR

DISCUSSION

In the 2018 AuSCR Annual Report, we present information on 20051 episodes of stroke and TIA collected at 71 hospitals across five states. This is the largest annual number of episodes to be added to the AuSCR within a calendar year, representing an increase of 41% when compared to 2017, and 66% when compared to 2016.

The AuSCR continued to grow in 2018 and we welcome the first full year of data collection by 15 acute thrombolytic centres in NSW and three in SA. In 2019 we expect to add another two hospitals in the ACT. We are also working with the Western Australian (WA) Government to secure funding for hospitals in the near future. With the addition of the ACT and WA, the coverage of the AuSCR will span all states and territories by 2020 except the Northern Territory. This will provide a rich, nationally representative dataset for quality improvement initiatives and benchmarking.

In 2018, we also held our first National Stroke Registry Forum, which was held as part of the Stroke Society of Australasia (SSA) meeting. It was a great success, with international guest speakers Avril Drummond and Ben Bray from the United Kingdom Sentinel Stroke National Audit Programme (SSNAP)[11] presenting and involved in panel discussions. We were reassured that many of the local challenges that the AuSCR faces have also been experienced elsewhere. The Forum also enabled the launch of the inaugural AuSCR awards for quality of care excellence (Appendix G) and data completeness. It was exciting to learn that some of the nine award recipients have successfully used this recognition to obtain positive media coverage, as well as leverage local funding. Congratulations to all recipients and we hope that these awards will be an inspiration to other hospitals to use their AuSCR data for vital quality improvement activities.

Acute care for stroke

Overall, there was little improvement in key processes of care in 2018 compared to 2017 including: care in a stroke unit; prescription of antihypertensive, antithrombotic and lipid lowering medications at discharge. One explanation for this finding is the addition of 18 new hospitals in two states which may have masked any larger changes in hospitals who had commenced participation prior to 2018.

Provision of a discharge care plan showed increased by three percent in 2018 but the overall rate remained low at 62%. The continued low rate of provision of discharge care plans continue to be of concern given their relationship to positive patient outcomes.[12] Also of note, numerous hospital audits in 2018 suggest that while many sites are documenting that discharge care plans are provided, the standard of these documents does not always meet the definition in the AuSCR data dictionary. Therefore, the estimate of 62% in this report may be an overestimate of formal discharge care plans provided. AuSCR State Coordinators will continue to work with hospitals around understanding the definition of this variable.

Of continued concern is that, on average, only one in two patients received dysphagia screening or assessment prior to oral intake (49%). This care process is vital for patient safety following stroke,[12] and has been shown to

be amenable to intervention in the ED.[2,3] The introduction of the Fever, Sugar, Swallow (FeSS) dataset to the AuSCR in 2019 will be an important asset to hospitals that wish to do additional quality improvement with respect to this evidence-based intervention.

The prescription of all stroke prevention medications at the time of discharge also continues to be low at 54%. Interestingly, those more likely to receive all three medications were male and living in a regional area. This is a finding that will need to be further investigated in order to support clinical practice.

For the first time, we have shown that the provision of intravenous thrombolysis varies significantly by state ranging from 7% in Tasmania to 18% in SA, a finding that was also evident in the National Stroke Audit of Acute Services.[13] We have also illustrated a significant divide between the use of thrombolysis in metropolitan and regional areas, highlighting a lack of equity in access to reperfusion treatments. Door-to-needle times also showed very little change in comparison with 2017. Another new observation was that onset-to-arrival times were significantly, and inversely, related to door-to-needle times. This supports findings from the United States,[14] and suggests that when patients present sooner after stroke onset, clinicians may fail to prioritise thrombolysis at some hospitals. Both the use of thrombolysis and door-to-needle times rate poorly against those documented in the UK and United States of America.[15-18] An improved ability to document thrombolysis in the ED which will be provided with the introduction of the Emergency Department (ED) dataset to the AuSCR in 2019 may therefore enable additional quality improvement activities around these care processes in the future.

Admission and discharge timing can also affect the type of care received. For the second consecutive year we have shown that patients discharged on a weekend less often receive key quality of care indicators such as: care in a Stroke Unit, the provision of preventative discharge medications and discharge care plans.[19] We also identified that patients admitted outside of the hours of 8am to 6pm on weekdays were also less likely to: have door-to-needle times under 60 minutes; receive ECR, and if they did receive ECR, had longer door-to-groin times. Given the importance of all of these processes for increasing the likelihood of better patient outcomes,[12] it is vital that these disparities in care provision be addressed. In 2019, new ways for the AuSCR to be involved with decreasing disparities in care provision between hospitals are planned and may include the formation of a Clinical Quality Improvement Committee.

Follow-up data collection

The overall rate of follow-up completion for eligible registrants increased to 69% from 65% (in 2017) and is a high rate of completion when compared to other international stroke registries such as SSNAP, which completes patient follow-up on 30% of eligible patients.[20] In 2018, the AuSCR office completed 4000 more follow-ups than in the 2017 calendar year, and the maintenance of the overall rate of eligible patient follow-up is testament to the hard work and refined protocols of the AuSCR office. Nonetheless, as the AuSCR continues to grow, the need to identify and implement more cost-effective mechanisms of patient follow-up increases. In 2019 we plan to build an electronic version of the current follow-up form which would enable distribution via SMS messaging. A protocol to test this new data collection mechanism is also planned.

Case mix adjusted analyses of the EQ-5D-3L VAS showed a 16 point difference between best and worst hospital-based results, and exceeds the reported clinically meaningful difference of nine points.[9] Assessment of the five domains of the EQ-5D also showed that for four of the five domains there were significant inter-hospital differences (pain/discomfort, self care, usual activities and mobility). Anxiety and depression was the exception. Further analysis to explore the contributing factors to these variations in HRQoL domains is required. These results suggest that results from the VAS and EQ-5D domains may also play an important role in QI

programs such as STELAR, StrokeLink and the Tasmanian Community of Practice program. The best formats to use PROMS data for feedback to clinicians is also being assessed in 2019 in a project funded by the Victorian Agency for Health Information, and we look forward to reporting the results in our next report.

Data quality

The AuSCR office will continue to work with hospitals in relation to improving documentation of the NIHSS, and other variables. The overall rate of case ascertainment decreased by five percent to 76% in 2018. This decrease was potentially a reflection of many new hospitals commencing data contributions to the AuSCR in 2018 and not supplying 12 months of admissions data to enable these calculations. The AuSCR office will continue to work with new AuSCR hospitals to highlight the importance of case ascertainment. In 2019, the AuSCR will also explore with various state governments the use of central upload of diagnosis discharge codes to reduce the workload for each hospital with this aspect of data quality.

Conclusion

Every patient with stroke has the right to be provided with evidence based care regardless of their geographic location. The findings presented in this report provide important insights into aspects of care to be improved to optimise patient outcomes after stroke in Australia. These findings also underpin the continued importance of evidence-based quality improvement programs such as StrokeLink and STELAR to assist with decreasing disparities in acute stroke care provision nationally.

REFERENCES

1. Australian Commission on Safety and Quality in Health Care. Operating Principles and Technical Standards for Australian Clinical Quality Registries. Sydney: ACSQHC, 2008 November
2. Middleton S, McElduff P, Ward J, Grimshaw JM, Dale S, D'Este C, Drury P, Griffiths R, Cheung NW, Quinn C, Evans M, Cadilhac D, Levi C, 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. The Lancet 2011;378(9804):1699-1706.
3. Middleton S, Coughlan K, Mnatzaganian G, Choy NL, Dale S, Jammali-Blasi A, Levi C, Grimshaw JM, Ward J, Cadilhac D, McElduff P, Hiller JE, D'Este C. Mortality reduction for fever, hyperglycaemia and swallowing nurse-initiated stroke intervention QASC Trial (Quality in Acute Stroke Care) follow-up. Stroke 2017;48:1331-1336.
4. Cadilhac DA, Lannin NA, Anderson CS, et al. Protocol and pilot data for establishing the Australian Stroke Clinical Registry. International Journal of Stroke 2010;5:217-226.
5. Evans SM, Loff B, Cameron PA. Clinical registries: the urgent need to address ethical hurdles. Med J Aust 2013;198:134-135.
6. Kiefe CI, Weissman NW, Allison JJ, Farmer R, Weaver M, Williams OD. Identifying achievable benchmarks of care: concepts and methodology. International journal for quality in health care : journal of the International Society for Quality in Health Care / ISQua 1998;10:443-447.
7. Hall RE, Khan F, Bayley MT, et al. Benchmarks for acute stroke care delivery. International journal for quality in health care : journal of the International Society for Quality in Health Care / ISQua 2013;25:710-718.
8. Australian Commission on Safety and Quality in Health Care. Acute Stroke Clinical Care Standard. Sydney: ACSQHC, 2015.
9. Spiegelhalter DJ. Funnel plots for comparing institutional performance. Statistics in Medicine 2005;24:1185-1202.
10. Kind P, Dolan P, Gudex C, Williams A. Variations in population health status: results from a United Kingdom national questionnaire survey. BMJ 1998;316:736-741.
11. https://www.strokeaudit.org/About-SSNAP.aspx
12. https://informme.org.au/Guidelines/Clinical-Guidelines-for-Stroke-Management
13. Stroke Foundation. National Stroke Audit – Acute Services Report 2019. Melbourne, Australia.
14. Saver JL et al. The "golden hour" and acute brain ischemia: presenting features and lytic therapy in >30,000 patients arriving within 60 minutes of stroke onset. Stroke 2010 Jul;41(7):1431-9.
15. Sentinel Stroke National Audit Programme (SSNAP) National results, June 2019. Available at: https://www.strokeaudit.org/Documents/National/Clinical/Apr2017Mar2018/Apr2017Mar2018-AnnualReport.aspx
16. NHS National Services Scotland. Scottish Stroke Improvement Report - 2019. Available at: http://bit.ly/29uWaYZ
17. Xian Y, Xu H, Lytle B, Blevins J, Peterson ED, Hernandez AF, et al. Use of Strategies to Improve Door-to-Needle Times With Tissue-Type Plasminogen Activator in Acute Ischaemic Stroke in Clinical Practice: Findings from Target: Stroke. Circ Cardiovasc Qual Outcomes. 2017; 10(1). pii: e003227.

18. Tong X, Wiltz JL, George MG, Odom EC, Coleman King S, Chang T, et al. A Decade of Improvement in Door-to-Needle Time Among Acute Ischaemic Stroke Patients, 2008 to 2017. Circ Cardiovasc Qual Outcomes. 2018; 11(12):e004981.

19. Kilkenny MF, Lannin NA, Levi C, Faux SG, Dewey HM, Grimley R, Hill K, Grabsch B, Kim J, Hand P, Crosby V, Gardner M, Rois-Gnecco J, Thijs V, Anderson CS, Donnan G, Middleton S, Cadilhac DA. Weekend hospital discharge is associated with sub-optimal care and outcomes: an observational Australian Stroke Clinical Registry study. International Journal of Stroke 2018 published online October 22.

20. SSNAP Annual Public Report 2018 Author SSNAP, School of Population Health and Environmental Sciences, King's College London on behalf of the Intercollegiate Stroke Working Party Publication June 2019

21. Cadilhac DA,Grimley R, Kilkenny MF, Andrew NE, Lannin NA, Hill K, Grabsch B, Levi CR, Thrift AG, Faux SG, Wakefield J, Cadigan G, Donnan GA, Middleton S, Anderson CS. Multicenter, prospective, controlled before-and-after quality improvement study (Stroke123) of acute stroke care. Stroke. 2019 Jun;50(6):1525-1530. doi: 10.1161/STROKEAHA.118.023075.

22. Cadilhac DA, Andrew NE, Salama ES, et al. Improving discharge care: the potential of a new organisational intervention to improve discharge after hospitalisation for acute stroke, a controlled before–after pilot study. BMJ open 2017;7:e016010.

APPENDIX A: AUSCR GOVERNANCE AND COLLABORATIONS

The AuSCR initiative is undertaken by a consortium of two leading academic research institutes, The Florey Institute of Neuroscience and Mental Health (Stroke Division; AuSCR Data Custodian) and The George Institute for Global Health, and two leading non-government organisations, the Stroke Foundation and the Stroke Society of Australasia (SSA). Collectively, these organisations represent a broad section of the Australian clinical and scientific stroke community. Significant sanction from clinicians and professional associations for the AuSCR initiative has occurred through the AuSCR Consortium partners and the Australian Stroke Coalition (ASC), a network of clinicians and professional associations: (www.australianstrokecoalition.com.au).

The AuSCR Steering Committee provides: governance; maintains the confidence of all parties involved; and contributes to strategic direction. Professor Sandy Middleton continued to be the Chairperson in 2018. The Management Committee includes representatives from the consortium partner organisations, all members having clinical backgrounds in medicine, nursing or allied health. The Management Committee is responsible for the day-to-day operation of the AuSCR, with oversight from the Steering Committee, and works with the AuSCR Office to manage the ongoing operations of the registry. Professor Natasha Lannin was Acting Chair for most meetings subsequent to Professor Craig Anderson's relocation to China. (See Appendix B for committee membership lists.)

There has been highly valued support from the Victorian Stroke Clinical Network (VSCN), currently via Safer Care Victoria (SCV) and the Victorian Agency for Health Information (VAHI), and since mid-2015, Queensland Health through a joint project (QSQIP) with the Stroke Foundation. In addition, a new partnerships with the Agency for Clinical Innovation (ACI) in New South Wales and with ACT Health through a joint project with the Stroke Foundation are highly valued.

Collaborations are continuing with staff from the Australian Institute of Health and Welfare, the Population Health Research Network and data linkage units based in health departments within various states (VIC, WA, QLD and NSW) to work through the processes to enable the linking of the AuSCR data with government data such as the NDI and state level admitted episode datasets and emergency department admissions.

In Victoria, we have continued our collaboration with the Victorian Stroke Telemedicine (VST) program. This approach is mutually beneficial since the VST is required to report to government funders on the rates of intravenous thrombolysis use, and the AuSCR provides a system that can be embedded as part of routine health care monitoring to reliably obtain these data.

In May 2018, we were supported by Amgen and Shire in conducting a national workshop on stroke data and quality that was co-convened with the Stroke Foundation and the VSCN. Such events provide additional opportunities for clinicians and academics to be involved in translational activities to further enhance stroke care and outcomes.

A continuing significant collaboration has been that of working closely with the Stroke Foundation and the ASC to refine the AuSDaT to achieve our common goal of a more efficient, standardised approach to stroke data collection in Australia.

APPENDIX B: COMMITTEE MEMBERSHIP

AuSCR Steering Committee membership 2018

Prof Sandy Middleton (Chair)	Director, Nursing Research Institute, St Vincent's Health Australia (Sydney) & Australian Catholic University [NSW]
Prof Craig Anderson	Executive Director, The George Institute, China & Professor of Neurology and Epidemiology, Faculty of Medicine, UNSW Sydney [NSW]
Ms Toni Aslett	Executive Director, Stroke Services, Stroke Foundation [VIC]
Prof Julie Bernhardt	Head, Stroke Division, Florey Institute of Neuroscience and Mental Health [VIC]
Prof Christopher Bladin	Director, Victorian Stroke Telemedicine Program, The Florey Institute of Neuroscience and Mental Health & Neurologist Eastern Health [VIC]
Mr Greg Cadigan	Project Manager, Queensland Statewide Stroke Clinical Network [QLD]
Prof Dominique Cadilhac	Head, Public Health, Stroke Division, Florey Institute of Neuroscience and Mental Health & Head, Translational Public Health Division, Stroke and Ageing Research, Monash University [VIC]
Dr Helen Castley	Neurologist, Royal Hobart Hospital & Co-chair, Clinical Advisory Group (Neurology & Stroke) [TAS]
Prof Geoffrey Donnan	Director, Florey Institute of Neuroscience and Mental Health [VIC]
Dr Andrew Evans	Geriatrician & Stroke Physician, Westmead Hospital [NSW]
Dr Rohan Grimley	Conjoint Senior Lecturer Sunshine Coast Clinical School & Chair, Queensland State-wide Stroke Clinical Network [QLD]
A/Prof Peter Hand	Neurologist, Royal Melbourne Hospital & Clinical Lead, Victorian Stroke Clinical Network [VIC]
A/Prof Susan Hillier	Dean, Research (and Research Education), Division of Health Sciences, University of South Australia [SA]
Prof Richard Lindley	Professorial Fellow, The George Institute for Global Health & Professor of Geriatric Medicine, Sydney Medical School, University of Sydney [NSW]
A/Prof Mark Mackay	Paediatric Neurologist, Royal Children's Hospital, Melbourne [VIC]
Prof John McNeil	Head, Department of Epidemiology and Preventive Medicine, Monash University [VIC]
A/Prof Michael Pollack	Chair, Hunter Stroke Service [NSW]
Mr Mark Simcocks	Consumer Representative, Self-employed [VIC]
Ms Frances Simmonds	Director, Australasian Rehabilitation Outcomes Centre, University of Wollongong [NSW]
Prof Amanda Thrift	Head, Epidemiology and Prevention Division, Stroke and Ageing Research, Monash University [VIC]
Dr Andrew Wesseldine	Geriatrician and Stroke Physician, St John of God Subiaco & State Stroke Director [WA]

APPENDIX B (CONTINUED): COMMITTEE MEMBERSHIP

AuSCR Management Committee membership 2018

Prof Craig Anderson (Chair, January-August)	Executive Director, The George Institute, China & Professor of Neurology and Epidemiology, Faculty of Medicine, UNSW Sydney [NSW]
Prof Natasha Lannin (Acting Chair, January-August Chair, September-December)	Associate Professor, School of Allied Health, La Trobe University, & Head of Occupational Therapy Research, Alfred Health [VIC]
Prof Dominique Cadilhac	Head, Public Health, Stroke Division, Florey Institute of Neuroscience and Mental Health & Head, Translational Public Health Division, Stroke and Ageing Research, Monash University [VIC]
Prof Helen Dewey	Director of Neurosciences, Eastern Health & Professor, Eastern Health Clinical School, Monash University [VIC]
Prof Geoffrey Donnan	Director, Florey Institute of Neuroscience and Mental Health [VIC]
A/Prof Steven Faux	Director, Rehabilitation Unit, St Vincent's Hospital, Sydney [NSW]
Dr Rohan Grimley	Conjoint Senior Lecturer, Sunshine Coast Clinical School & Clinical Chair, Queensland Statewide Stroke Clinical Network [QLD]
A/Prof Peter Hand	Neurologist, Royal Melbourne Hospital & Clinical Lead, Victorian Stroke Clinical Network [VIC]
Mr Kelvin Hill	National Manager, Clinical Services, Stroke Foundation [VIC]
Prof Chris Levi	Director of Clinical Research and Translation - Research Innovation and Partnerships & Co-Director of Acute Stroke Services, John Hunter Hospital [NSW]

APPENDIX B (CONTINUED): COMMITTEE MEMBERSHIP

AuSCR Research Task Group membership 2018

The primary purpose of the Research Task Group is to ensure appropriate use and protection of the Australian Stroke Clinical Registry data when it is to be used for research purposes by third parties.

A/Prof Sue Evans (Co-Chair)	Head of the Clinical Registry Unit & Associate Director of the Centre of Research Excellence in Patient Safety Medicine, Nursing & Health Services, Monash University [VIC]
Prof Richard Lindley (Co-Chair January-August)	Professorial Fellow, The George Institute for Global Health & Professor of Geriatric Medicine, Sydney Medical School, University of Sydney [NSW]
Dr Darshan Ghia (Co-Chair September-December)	Consultant Neurologist and Head of Stroke Unit, Fiona Stanley Hospital [WA]
A/Prof Coralie English	Senior Research Affiliate, NHMRC Centre for Research Excellence in Stroke Rehabilitation and Recovery, Priority Research Centre for Neuroscience and Mental Health, Hunter Medical Research Institute [NSW]
Prof John McNeil	Head, Department of Epidemiology and Preventive Medicine, Monash University [VIC]
A/Prof Erin Godecke	Senior Research Fellow (Speech Pathology), School of Medical & Health Sciences, Edith Cowan University [WA]
Dr Benjamin Clissold	Head, Inpatient Services (Neurosciences), Barwon Health & Stroke Neurologist, University Hospital Geelong and Monash Medical Centre [VIC]
Dr Philip Choi	Consultant Neurologist, Department of Neurosciences, Eastern Health [VIC]
Prof Suzanne Kuys	National Head, School of Physiotherapy, Australian Catholic University & Principal Research Fellow, Queensland Health [QLD]
Prof Bernard Yan	Neurointerventionist and Neurologist, Royal Melbourne Hospital [VIC]

AuSCR Reperfusion and Telemedicine Subcommittee membership 2018

A/Prof Bruce Campbell (Co-Chair)	Head, Hyperacute Stroke, Royal Melbourne Hospital [VIC]
Prof Peter Mitchell (Co-Chair)	Head, Statewide Endovascular Clot Retrieval Service [VIC]
A/Prof Peter Hand	Neurologist, Royal Melbourne Hospital [VIC]
Prof Dominique Cadilhac	Head, Public Health, Stroke Division, Florey Institute of Neuroscience and Mental Health & Head, Translational Public Health Division, Stroke and Ageing Research, Monash University [VIC]
Prof Bernard Yan	Neurointerventionist and Neurologist, Royal Melbourne Hospital [VIC]
A/Prof Henry Ma	Neurologist, Monash Medical Centre & Adjunct Senior Lecturer, Stroke and Ageing Research Group, Southern Clinical School, Monash University [VIC]
Dr Andrew Wong	Neurologist, Royal Brisbane and Women's Hospital [QLD]
Dr Ferdi Miteff	Neurologist, Royal North Shore Hospital [NSW]
Prof Alan Coulthard	Head, Discipline of Medical Imaging, University of Queensland [QLD]
Prof Christopher Bladin	Director, Victorian Stroke Telemedicine Program, The Florey Institute of Neuroscience and Mental Health & Neurologist Eastern Health [VIC]

APPENDIX C: FUNDING 2018

In 2018, the AuSCR Office was supported by funding and in-kind support from the following sources:

- The Florey Institute of Neuroscience and Mental Health
- Industry partners including Ambulance Victoria, Boehringer Ingelheim, University of South Australia, Murdoch Children's Institute
- Joint initiatives with the Stroke Foundation funded by Queensland Health and ACT Health
- Safer Care Victoria and the Victorian Agency for Health Information
- The Agency for Clinical Innovation in New South Wales
- The NHMRC, which provides salary via fellowship awards for senior researchers which has assisted in containing staff costs
- Members of the Management Committee and Steering Committee and Research Task Group provide their time 'in-kind'

ORGANISATION	AMOUNT
State Governments	$752082
The Florey	$19271
Monash University*	$27310
Non-government organisations	$47000
Industry	$108582
Hospital opt-in payment	$0
Consumer donations	$0
Other**	$55986
TOTAL	$1010231

Cost recovery through collaboration on external grants.

***Includes income from projects approved by the Research Task Group to access the AuSCR data/registrants.*

APPENDIX D: ACKNOWLEDGEMENTS

Ongoing contribution to the AuSCR

We gratefully acknowledge contributions made by:

- The AuSCR staff at the Florey Institute of Neuroscience and Mental Health (The Florey): Julie Morrison, Emma Tod, Natalie Wilson, Kate Paice, Karen Barclay Moss, Jot Ghuliani, Helen Carter, Adele Gibbs, Perrin Date, Violet Marion, Nancy Pompeani, Olivia Ryan, Claire Weickhardt, Rumer Kennedy, Lilian Braighi Carvalho, Ruby Lipson-Smith and Shaun Hancock;
- The epidemiologists from the Stroke and Ageing Research Centre, School of Clinical Sciences, Monash University: Dr Joosup Kim, Dr Monique Kilkenny and Lachlan Dalli;
- Professor Leonid Churilov (The Florey) for expert statistical advice;
- The Florey Information Technology team in supporting the AuSCR server hosting and other technical processes;
- The VSCN, through Safer Care Victorian and the Victorian Agency for Health Innovation, for generous financial support of the AuSCR operations in VIC;
- QLD Health for support of the AuSCR in QLD via a joint project (QLD Stroke Quality Improvement Program [QSQIP]) with the Stroke Foundation;
- ACT Heath for support of the AuSCR in the ACT via a joint project with the Stroke Foundation;
- The Agency for Clinical Innovation through State Government of NSW for the generous support of AuSCR operations in NSW;
- The Stroke Foundation for providing AuSCR registrants with stroke information packages to registrants requesting additional information at the 90-180 day follow-up;
- The Australian Institute of Health and Welfare for their role in linking the AuSCR data to the National Death Index.

Contribution to annual report

The Florey AuSCR Office

Dr Sibilah Breen, the AuSCR National Coordinator, was responsible for overall coordination of the AuSCR program and support to participating hospitals and other AuSCR program staff and collaborators.

Sam Shehata, the National Data Manager, has been essential in maintaining the integrity of the database, facilitating data quality checks and providing information for the completeness of data, opt-out and case ascertainment tables.

Monash University

Drs Joosup Kim, Dr Monique Kilkenny and Lachlan Dalli (Stroke and Ageing Research Centre, Monash University) developed and conducted the AuSCR data analyses for this report and as required throughout 2018. We are most appreciative of their contributions. The majority of analyses presented in this report were undertaken by Dr Joosup Kim, Research Fellow, under the supervision of Professor Dominique Cadilhac using de-identified data supplied securely by Sam Shehata. Dr Monique Kilkenny was responsible for establishing the methodology for the analysis of the risk adjusted mortality rate data (in consultation with Professor Leonid Churilov from The Florey).

APPENDIX D (CONTINUED): ACKNOWLEDGEMENTS

This report would not have been possible without the efforts of doctors, nurses, ward clerks and other staff from participating hospitals who have contributed data to the AuSCR. Lead clinical and data collection staff for each hospital participating in the AuSCR during 2018 are gratefully acknowledged below.

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Blacktown Hospital	Nigel Wolfe; Camelia Burdusel
Dubbo Base Hospital	Debra Sloane
John Hunter Hospital	Jody Vaipulu; Rhonda Walker; Malcolm Evans; Annalese Johnson
Lismore Base Hospital	Stephen Moore; Kim Hoffman
Nepean Hospital	Salman Khan; Susan Lane; Sebastian Saj
Orange Base Hospital	Fiona Ryan
Port Macquarie Hospital	Kim Parrey; Michelle Coad
Prince of Wales Hospital	Alessandro Zagami; Alanah Bailey; Briony Van Galen
Royal North Shore Hospital	Martin Krause; Carin Bertmar; Sheila Jala
St George Hospital	Jane Prosser; Louise Allport; Krystle Franklin; Sheila Pomfret
St Vincent's Hospital NSW	Romesh Markus; Kirsty Page; Deborah Holmes
Wagga Wagga Rural Referral Hospital	Martin Jude; Katherine Mohr
Westmead Hospital	Andrew Evans; Jacqueline Watson
Wollongong Hospital	Karen Fuller; Toni Wonson
QLD	
Bundaberg Base Hospital	Michele Gardner; Sonia Dann; Helen Eaves; Cindy Tottman
Caboolture Hospital	Jonnel Boco
Cairns Base Hospital	Ramesh Durairaj; Dijana Cukanovic-Krebs; Troy Reidy
Gold Coast University Hospital	Meng Tan; Haylee Berrill
Gympie Hospital	Rohan Grimley; Rebecca Sjodin
Hervey Bay Hospital	Michele Gardner; Pauline Blaney
Ipswich Hospital	Juan Rois-Gnecco; Linda Edwards; Betzy Shaju
Logan Hospital	Alex Lau; Nicola Hall
Mackay Base Hospital	Donna Leary; Anne Hooper; Melinda Spring
Mater Health Services	Daniel Schweitzer; Marie McCaig
Prince Charles Hospital	Alaa Alghamry; Kathryn Colebourne; Caitlin Kearney
Princess Alexandra Hospital	Darshan Shah; Kate Jaques; Amanda McKee
Queen Elizabeth II Jubilee Hospital	Amanda Siller; Jerry Wong; Evelyn Anino
Redcliffe Hospital	Richard Geraghty; Casey Jenkins
Redland Hospital	Joel Iedema; Raylene Williams
Robina Hospital	Meng Tan; Haylee Berrill
Rockhampton Hospital	Leanne Whiley
Royal Brisbane and Women's Hospital	Andrew Wong; Melissa Wood; Tara Hormann; Lisa Wesley
Sunshine Coast University Hospital	Rohan Grimley; Donna Rowley; Dawn Harwood
Toowoomba Hospital	Nisal Gange; Timothy Richardson
Townsville Hospital	Richard White; Sheryl Juliano; Alexandra Watson; Linda Roper
Wesley Hospital	Noel Saines; Raewyn Beu

APPENDIX D (CONTINUED): ACKNOWLEDGEMENTS

SA

Flinders Medical Centre	Matt Willcourt; Michelle Bronca; Michelle Hutchinson; Amanda James
Lyell McEwin Hospital	Andrew Moey; Angela Sayas
Royal Adelaide Hospital	Tim Kleinig; Lizzie Dodd; Anthea Worley; Carole Hampton

TAS

Launceston General Hospital	Dinesh Tryambake
North West Regional Hospital	Maxine Munting
Royal Hobart Hospital	Helen Castley; Deirdre Broadby

VIC

Albury Wodonga Health - Albury	Vanessa Crosby
Albury Wodonga Health - Wodonga	Vanessa Crosby
Alfred Hospital	Jorge Zavala; Carla Borg Caruana
Austin Hospital	Vincent Thijs; Renae Gamble; Alexandra Warwick
Bairnsdale Regional Health Service	Kushantha Gunarathne; Nelly Counihan
Ballarat Health Services	Thomas Kraemer; Casey Hair
Bass Coast Health	Cath Jones
Bendigo Health	David Rosaia; Tessa Coupland; Erin Ray
Box Hill Hospital	Helen Dewey; Tanya Frost
Central Gippsland Health Service	Krishna Mandaleson; Anne van Berkel
Echuca Hospital	Lauren Arthurson
Goulburn Valley Health	Melanie Brown
Hamilton Base Hospital	Louise Starkie
Latrobe Regional Hospital	Janet May
Maroondah Hospital	Helen Dewey; Tanya Frost
Mildura Base Hospital	Bronwyn Daymond; Mandie Hayes; Ros Roberts
Monash Medical Centre	Henry Ma; Jodi Lynch
Northeast Health Wangaratta	Rebecca Weir; Lyn Malone
Peninsula Health - Frankston Hospital	Ernie Butler; Margaret Stevenson; Kanaga Lagma
Royal Children's Hospital	Mark Mackay; Belinda Stojanovski
Royal Melbourne Hospital	Mark Parsons; Lauren Pesavento; Smisha Thomas
St Vincent's Hospital Melbourne	Lauren Sanders; Patrick Scarff
Swan Hill District Health	Trish Oxley; Emma Mollo
The Northern Hospital	Douglas Crompton; Anne Rodda
University Hospital Geelong	Ben Clissold; Heather Smith
Warrnambool Base Hospital	Anna Clissold; Patrick Groot
West Gippsland Hospital	Brett Forge; Lorraine Keene; Amanda Lewis; Ashley Murray
Wimmera Base Hospital	Chris Ebersohn; Jarrod Hunter; Kerri Chamberlain

APPENDIX E: PUBLICATIONS AND PRESENTATIONS

Journal Publications

Andrew N, Busingye, D, Lannin, NA, Kilkenny, MF, Cadilhac, DA. The Quality of Discharge Care Planning in Acute Stroke Care: Influencing Factors and Association with Postdischarge Outcomes. Journal of Stroke and Cerebrovascular Diseases. 2018;27(3):583-90.

Andrew N, Kim, J, Thrift AG, Kilkenny MF, Lannin NA, et al. Prescription of antihypertensive medication at discharge influences survival following stroke. Neurology. 2018;90(9):e745-53.

Bagot K, Moloczij, N, Barclay-Moss, K, Vu, M, Bladin, CF, Cadilhac, DA. Sustainable implementation of innovative, technology-based health care practices: A qualitative case study from stroke telemedicine. Journal of Telemedicine and Telecare. Jan-Feb 2020, 26(1-2):79-91.

Busingye D, Kilkenny, MK, Purvis, T, Kim, J, Middleton, S, et al. Is length of time in a stroke unit associated with better outcomes for patients with stroke in Australia? An observational study. BMJ Open. 2018;8(11):e022536.

Cadilhac DA, Andrew, NE, Kilkenny, MF, Hill, K, Grabsch, B, et al. Improving quality and outcomes of stroke care in hospitals: Protocol and statistical analysis plan for the Stroke123 implementation study. International Journal of Stroke. 2018;13(1):96-106.

Chapman C, Morgan, P, Cadilhac, DA, Purvis, T, Andrew, NE. Risk factors for the development of chest infections in acute stroke: a systematic review. Topics in Stroke Rehabilitation. 2018;25(6):445-58.

Kilkenny MF, Lannin, NA, Anderson, CS, Dewey, HM, Kim, J, et al. Quality of Life Is Poorer for Patients With Stroke Who Require an Interpreter: An Observational Australian Registry Study. Stroke. 2018;49(3):761-4.

Kilkenny MF, Lannin, NA, Levi, C, Faux, SG, Dewey, HM, et al. Weekend hospital discharge is associated with suboptimal care and outcomes: An observational Australian Stroke Clinical Registry study. International Journal of Stroke. 2018;14(4):430-8.

Thayabaranathan T, Andrew, NA, Kilkenny, MF, Stolwyk, R, Thrift, AG, et al. Factors influencing self-reported anxiety or depression following stroke or TIA using linked registry and hospital data. Quality Of Life Research: An International Journal Of Quality Of Life Aspects Of Treatment, Care And Rehabilitation. 2018;27(12):3145-55.

Annual Report Publication

Breen S, Cadilhac DA, Lannin NA, Kim J, Dalli L, Anderson CS, Kilkenny M, Shehata S, Faux S, Dewey H, Hill K, Donnan G, Grimley R, Campbell B, Mitchell P, Middleton S on behalf of the AuSCR Consortium. The Australian Stroke Clinical Registry Annual Report 2018. The Florey Institute of Neuroscience and Mental Health; December 2019, Report No. 10, 70 pages.

Presentations and posters

Andrew NE, Kilkenny, MF, Sundararajan, V, Thrift, AG, Anderson, P, et al. New frontiers in stroke data linkage: linking national stroke data with Medicare and pharmaceutical claims data. International Journal of Stroke. 2018;13(1S):18 [Abstract].

Cadilhac DA. Economic evaluation and determining the costs of stroke care in research trials. NIHR Global Health Research Group for improving stroke care in India, Masterclass – Programme 17th March 2018, Indian National Stroke Conference, New Delhi - Keynote speaker (March).

Cadilhac DA. Sex difference in specific-cause mortality after stroke: the Australian Stroke Clinical Registry. 4th European Stroke Organisation Conference, Gothenburg, Sweden (International Oral E-Poster discussion presentation - Epidemiology) (May).

Cadilhac DA. STROKE123: results from a multicentre, controlled before-and-after study to improve acute stroke care in Australia. 4th European Stroke Organisation Conference, Gothenburg, Sweden (International Plenary Speaker (selected from abstract) (Presidential Symposium: Awards & Trials) (May).

Cadilhac DA. Lessons learnt from conducting clinical trials, data linkage projects and evaluations of models of care in stroke populations: opportunities for the field of psychology. Keynote speaker - Organisation for Psychological Research into Stroke (OPSYRIS) Australia: 2018 Annual Research Meeting, Melbourne (16th November).

Cadilhac DA. Measuring the outcomes of a large scale program. Measuring Health Outcomes Conference, Melbourne (6th December).

Churilov, L, Kilkenny, M, Donnan, G, Cadilhac, D. A novel cross-evaluation approach to comparing hospital performance on stroke outcomes: example using data from the Australian Stroke Clinical Registry. International Journal of Stroke. 2018;13(2S):58 [Abstract].

Dewey H, Grimley, R, Kim, J, Anderson, C, Lannin N, et al. Factors associated with contraindications to secondary prevention medications. International Journal of Stroke. 2018;13(1S):21 [Abstract].

Kilkenny M, Kim, J, Sundararajan, V, Andrew, N, Dewey, H, et al. Factors associated with 90-day readmissions after stroke using linked Australian Stroke Clinical Registry and hospital data. International Journal of Stroke. 2018;13(2S):17 [Abstract].

Kilkenny M, Lannin, N, Kim, J, Thrift, AG, Hill, K, et al. Stroke care and outcomes for Australian Aboriginal and non-Aboriginal patients: observational study from the Australian Stroke Clinical Registry. International Journal of Stroke 2018;13(1S):7 [Abstract].

Lannin N, Anderson, C, Kim, J, Donnan, G, Faux, S, et al. Temporal improvements in the quality of stroke care observed in the Australian Stroke Clinical Registry. International Journal of Stroke. 2018;13(1S):31 [Abstract].

Malavera A, Lim, JY, Breen, SJ, Thijs, V, Anderson, C, et al. Feasibility of screening for Fabry Disease in stroke: linked data from the Australian Stroke Clinical Registry (AuSCR). International Journal of Stroke. 2018;13(1S):19 [Abstract].

Phan H, Gall, S, Blizzard, L, Lannin, N, Thrift, A, et al. Differences in stroke care and outcomes after stroke for women compared to men: Australian Stroke Clinical Registry. International Journal of Stroke. 2018;13(2S):79 [Abstract].

Phan H, Gall, S, Blizzard, L, Lannin, N, Thrift, A, et al. Sex difference in specific-cause of excess death rates after stroke: the Australian stroke clinical registry (AuSCR). International Journal of Stroke. 2018;13(2S):35 [Abstract].

Phan H, Gall, S, Blizzard, L, Lannin, N, Thrift, A, et al. Sex Difference in Specific-Cause Mortality after Stroke: The Australian Stroke Clinical Registry. European Stroke Journal. 2018;3(1S):326 [Abstract].

Phan H, Gall, SL, Blizzard, L, Lannin, NA, Thrift, AG, et al. Lower Health-Related Quality of Life (HRQoL) At 3-6 Months After Stroke in Both Women and Men Compared to Those Without Stroke: An Observational Study From The Australian Stroke Clinical Registry (AuSCR). Stroke. 2018;49(1S): ATP175 [Poster]

APPENDIX F: APPLICATIONS TO THE AUSCR RESEARCH TASK GROUP

In 2018, there were four external applications reviewed by the Research Task Group:

- Investigation of the pre-hospital clinical and system factors that impact the initiation of reperfusion therapies in acute stroke (PI: Mr Wayne Loudon (PhD candidate); AIs: Assoc. Prof Andrew Wong, Prof Vivienne Tippett, Assoc. Prof Emma Bosley; Queensland University of Technology).
- Evaluation of enhanced models of primary care in the management of stroke and other chronic disease (PRECISE) (PI: Dr Nadine Andrew; AIs: Dr Monique Kilkenny, Dr Joosup Kim, Prof Dominique Cadilhac, Prof Vijaya Sundararajan, Prof Amanda Thrift, Prof Velandai Srikanth, Prof Leonid Churilov, Assoc. Prof Natasha Lannin, Prof Mark Nelson; Monash University).
- Understanding factors that influence pre-hospital and hospital patient care to improve access to high quality acute stroke care (PI: Prof Dominique Cadilhac; AIs: Prof Karen Smith, Dr Monique Kilkenny Dr Katie Bagot; The Florey Institute of Neuroscience and Mental Health/Monash University).
- Predicting Rehabilitation Outcomes through data linkage of the Australian Stroke Clinical Registry (AuSCR) and Australian Rehabilitation Outcomes Centre (AROC) (PI: Dr Monique Kilkenny; AIs: Dr Simon Mosalski, Dr Jane Wu, Dr Christine Shiner, Prof Dominique Cadilhac, Ms Frances Simmons, Assoc. Prof Steven Faux, Assoc. Prof Natasha Lannin; Monash University).

APPENDIX G: AUSCR AWARD CRITERIA AND RECIPIENTS

To be eligible for the AuSCR awards, participating hospitals were judged on eight key processes of care collected within the AuSCR. These processes of care included:

- Care in a stroke unit
- Thrombolysis provision for ischaemic stroke
- Provision of aspirin within 48 hours of stroke onset
- Swallow screen and/or assessment prior to oral intake
- Mobilised on the same day or day following stroke
- Provision of antithrombotics on discharge
- Provision of antihypertensives on discharge
- Provision of a discharge care plan

A composite score based on these eight processes of care was calculated by dividing the number of relevant clinical episodes for each episode by the sum of eligible indicators. To be eligible for an award the overall composite score for each hospital was required to be greater than or equal to 0.60. Awards were possible in three categories:

- Bronze: composite score of 0.60–0.69
- Silver: composite score of 0.70–0.79
- Gold: composite score equal or greater than 0.8.

In addition to achieving composite scores of equal to or greater than 0.60, hospital also had to fulfill the following data quality criteria in 2017:

- Have entered data into the AuSCR for the full 2017 calendar year
- Have an overall case ascertainment for the 2017 calendar year greater than or equal to 70%
- Have an average of less than 10% missing data for the eight processes of care plus two other key variables (stroke type and discharge destination)

The following hospitals were awarded BRONZE awards: Goulburn Valley Hospital, Latrobe Regional Health, Logan Hospital, Redcliffe Hospital and Redland Hospital.

The following hospitals were awarded SILVER awards: Box Hill Hospital, Central Gippsland Health Service, Townsville Hospital and Rockhampton Hospital.

No hospitals participating in the AuSCR were eligible for GOLD awards for data collected in the 2017 calendar year.

APPENDIX H: ABBREVIATIONS

ABC™	Achievable benchmarks of care
ACI	Agency for Clinical Innovation
ACT	Australian Capital Territory
AF	Atrial fibrillation
APF	Adjusted performance fraction
ARIA	Accessibility/Remoteness Index of Australia
ASC	Australian Stroke Coalition
AuSCR	Australian Stroke Clinical Registry
AuSDaT	Australian Stroke Data Tool
DVT	Deep vein thrombosis
ECR	Endovascular clot retrieval
ED	Emergency Department
EQ-5D-3L™	European Quality of Life - five dimension three level instrument
eTICI	expanded Thrombolysis In Central Infarction
FeSS	Fever Sugar Swallow
HRQoL	Health-related quality of life
ICD-10	International Classification of Diseases (Version 10)
ICH	Intracerebral haemorrhage
mRS	Modified Rankin Scale
NDI	National Death Index
NHMRC	National Health and Medical Research Council
NIHSS	National Institutes of Health Stroke Scale
NSW	New South Wales
Q1/Q3	25th percentile/75th percentile
QLD	Queensland
QSQIP	Queensland Stroke Quality Improvement Program
PE	Pulmonary embolism
PROMs	Patient reported outcome measures
RAMR	Risk adjusted mortality rate
SCV	Safer Care Victoria
SD	Standard deviation
SSA	Stroke Society of Australasia
STELAR	Shared Team Efforts Leading to Adherence Results
TAS	Tasmania
TIA	Transient ischaemic attack
tPA	Tissue plasminogen activator
UTI	Urinary tract infection
VAHI	Victorian Agency for Health Innovation
VAS	Visual Analogue Scale
VIC	Victoria
VSCN	Victorian Stroke Clinical Network
VST	Victorian Stroke Telemedicine

AuSCR

Australian Stroke Clinical Registry