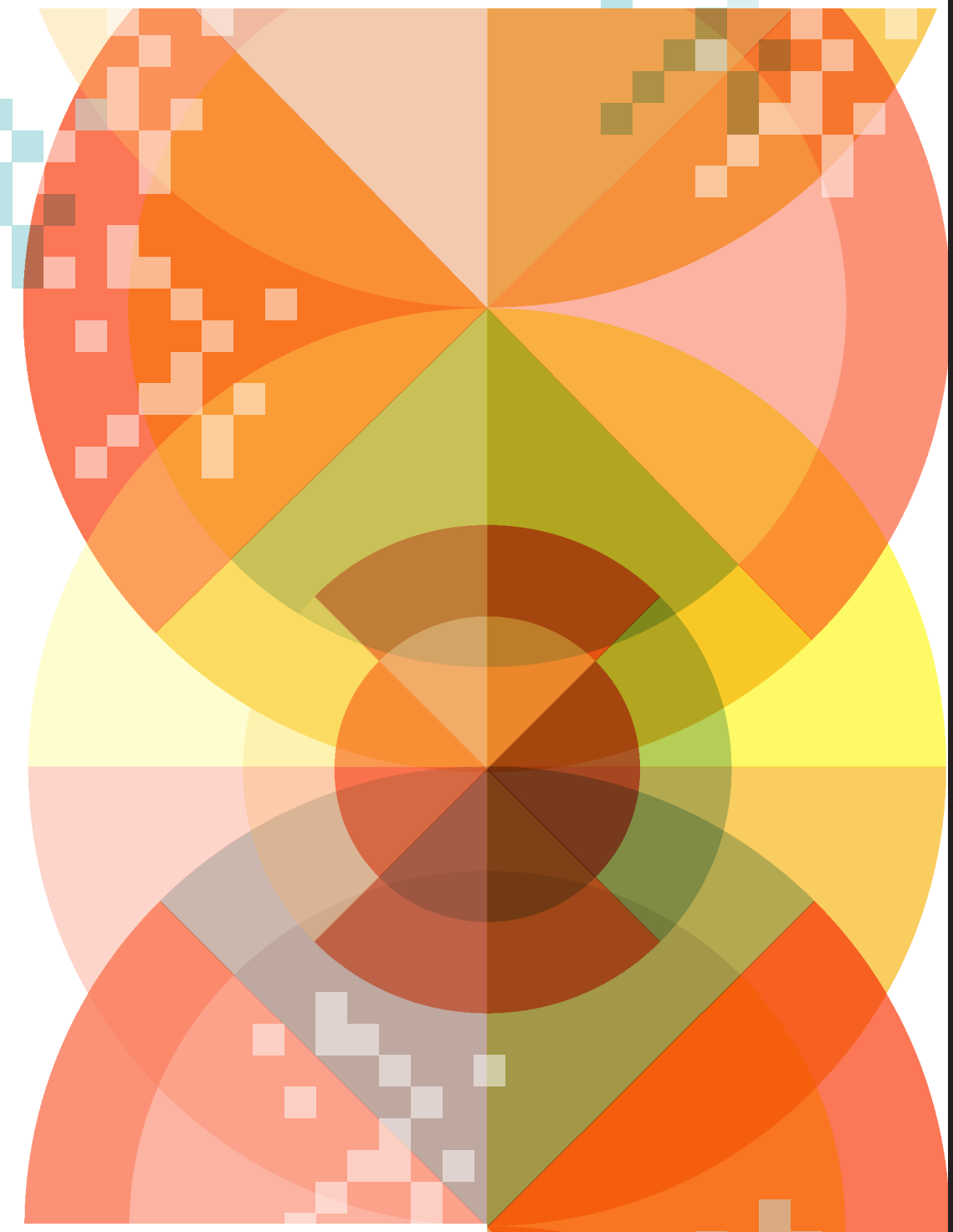
ANNUAL REPORT 2020



AuSCR

Australian Stroke Clinical Registry

This publication was produced on behalf of the Australian Stroke Clinical Registry (AuSCR) Consortium partners and was approved by the AuSCR Steering Committee.

Suggested citation:

Cadilhac DA, Dalli LL, Morrison J, Lester M, Paice K, Moss K, Carter H, Campbell B, Cloud G, Anderson CS, Kilkenny M, Faux S, Dewey H, Hill K, Donnan G, Grimley R, Middleton S, Lannin NA on behalf of the AuSCR Consortium. The Australian Stroke Clinical Registry Annual Report 2020. The Florey Institute of Neuroscience and Mental Health; December 2021, Report No. 13, 64 pages.

Any enquires about, or comments on, this publication should be directed to:

Administration
Australian Stroke Clinical Registry Office

The Florey Institute of Neuroscience and Mental Health
245 Burgundy Street
Heidelberg, Victoria 3084,
Australia

Ph: 1800 673 053

Email: **admin@auscr.com.au**

Website: **www.auscr.com.au**

@AustStrokeReg

December 2021

Report No. 13

Consortium partners

CONTENTS

List of Tables

List of Figures

EXECUTIVE SUMMARY

Highlights of the Australian Stroke Clinical Registry (AuSCR) for 2020

- In 2020, 68 hospitals contributed data to the AuSCR (43% from Victoria, 32% from Queensland, 12% from New South Wales; 4% each from Tasmania and South Australia; 3% from the Australian Capital Territory; and 1% from Western Australia).
- Information is presented on 19,861 patients with 21,512 presentations for acute stroke or transient ischaemic attack (TIA), and represents a 7% increase in total episodes from 2019 despite fewer hospitals contributing data (72 in 2019, 68 in 2020). Overall, 16% of patients were transferred from another hospital. Where the data were available to link between hospitals, we have reported data from the Emergency Department (ED) dataset of the hospital that transferred the patient, as well as from the receiving hospital providing the admission for stroke care.
- At 90-180 days after admission, collection of patient-reported outcomes was completed for 65% of all eligible patients. This is a testament to the AuSCR Office staff who were faced with additional challenges in 2020 in response to the Covid-19 pandemic, whereby staff had reduced ability to conduct patient follow-up on-site.
- To support hospitals, we conducted four educational webinars and co-convened the 8th National Stroke Quality Improvement Workshop which, for the first time, was held virtually.
- To better understand the unintended impacts of the COVID-19 pandemic on stroke care in hospitals we:
  - **a)** distributed two feedback surveys to hospital staff (May and August);
  - **b)** convened a committee to help disseminate the findings from analysis of the patient data from 2019 and 2020. The data were also fed back to the Victorian Department of Health on their request on three occasions (July, September and November), illustrating the importance of continuous, standardised data collection for acute stroke quality of care measures.
- AuSCR Paediatric dataset went live on 31 July. The newly developed AuSCR paediatric dataset forms an integral part of the Paediatric Acute Code Stroke (PACS) study, a national study funded by the Medical Research Future Fund and is supported by the Stroke Foundation.

Hospital performance against clinical care standards

- Overall, provision of stroke unit care was 73%, with the achievable benchmark of 93% derived from the top preforming hospitals. Patients with TIA (48%) or undetermined stroke type (44%) were less likely to access stroke units.
- Reperfusion therapies can be provided to patients with confirmed ischaemic stroke if they meet the eligibility criteria. In 2020, 11% of patients were provided intravenous thrombolysis compared to the achievable benchmark of 18%, highlighting variation in practice that exists among the participating hospitals. When limited to patients arriving within 4.5 hours of ischaemic stroke onset, only one in four were provided thrombolysis. Provision of thrombolysis was more common at hospitals where endovascular clot retrieval (ECR) was available (12%) than those not providing this intervention (10%; $p<0.007$). A total of 1263 patients at 13 hospitals received ECR. The median time from hospital arrival to recanalisation time was 91 minutes.
- Of those provided with thrombolysis, only one in three received treatment within 60 minutes of hospital arrival. Patients who were treated in an inner or outer regional hospital were less likely to have a door-to-needle time under 60 minutes compared than those treated at a metropolitan hospital (18% vs 35%; $p<0.001$).
- Several hospitals were found to be outside the limits set for normal variation in relation to the clinical care performance measures. Processes of care with the most variation were management in a stroke unit, swallow screen or assessment within four hours of arrival, and provision of a discharge care plan. Only three hospitals had a median door-to-needle time for thrombolysis less than 60 minutes.

- Although the achievable benchmark for the provision of a discharge care plan was 98% in 2020, a high level of variation was observed between hospitals and almost one in four patients missed out on receiving a plan at hospital discharge.
- In this report changes in adherence to quality indicators between 2017 and 2020 were also evaluated, among 47 hospitals that participated in the AuSCR throughout this period. We chose 2017 as this was the first full year of data collection in the Australian Stroke Data Tool (AuSDaT).
- Since 2017, we have seen steady improvements among these 47 hospitals in the proportion of patients prescribed the following medications at discharge:

  Antihypertensive: 70% in 2017 vs 75% in 2020

  Antithrombotic: 88% in 2017 vs 93% in 2020

  Lipid-lowering: 77% in 2017 vs 80% in 2020

  Patients with ischaemic stroke who received all three medications at discharge (62% of episodes) were more often aged ≥75 years, male, and living in a regional area, than those not prescribed all three medications.
- There has also been a steady improvement in access to most hyperacute and acute treatments since 2017 (hyperacute antithrombotic therapy, proportion receiving ECR, being mobilised, receiving a swallow screen/assessment within 4 hours or prior to food or drink).
- However, overall access to thrombolysis has remained unchanged since 2017, with nine in ten patients with ischaemic stroke missing out on this clot-busting drug. Of greater concern, there has been a decline in the proportion of patients receiving thrombolysis within 60 minutes.
- Despite improvements in access to stroke unit care between 2017 and 2019, there was a marked decline in 2020, which has been attributed to the impacts of the COVID-19 pandemic. Other impacts of COVID-19 on the quality of stroke care are reported in a new section on page 27.

Hospital and post-discharge outcomes

- Overall, 1,708 (9%) of the patients registered in the AuSCR died in hospital, similar to earlier years. Within 180 days of admission, 17% had died, and this varied by clinical diagnosis (intracerebral haemorrhage [ICH]: 38%; ischaemic stroke: 16%; undetermined stroke: 15%; TIA: 3%).
- After discharge from acute care, 23% of patients went to rehabilitation (23% in 2017) and 54% returned to their usual residence, with or without some form of support (50% in 2017).
- At the 90-180 day follow-up, 27% of 9,647 registrants who responded reported being free of disability symptoms on the modified Rankin Scale (mRS).
- With respect to health-related quality of life as measured by the European Quality of Life measure of health status (EQ-5D-3L): 47% of patients reported problems with mobility, 29% with self-care, 55% with completion of usual activities, 47% had pain/discomfort and 46% had anxiety or depression. The mean Visual Analogue Scale score was 69.
- A greater proportion of people living with ICH reported problems in all five dimensions of quality of life in contrast to those living with other types of stroke or TIA.
- Unmet information needs about stroke were reported by 47% of respondents whereby they sought to receive an information pack about stroke and support services from the Stroke Foundation.

Future contributions to research

- The AuSCR has a secondary role in maintaining a registry of potential research participants who are living with stroke. In 2020, 5,746 said they would be willing to be contacted for research invitations. Every year survival status is updated in the registry and the AuSCR currently has 30,395 people living with stroke who are willing to be contacted for research studies.
- Since 2009, there have been 21 research studies where the AuSCR office sent an invitation to eligible registrants (n=1,111) to participate in a project on behalf of investigators with approved projects.

GOVERNANCE REPORT

The challenges of 2020 and the COVID-19 pandemic have meant new or adapted ways of working and conducting meetings to support the AuSCR.

The challenges of 2020 and the COVID-19 pandemic have meant new or adapted ways of working and conducting meetings to support the AuSCR program. The governance of the AuSCR adheres with the operating principles and framework for Clinical Quality registries established by the Australian Commission for Safety and Quality in Healthcare.[1] In 2020, a strategy for national clinical quality and virtual registries was released.[2] The AuSCR continues to meet these adapted principles across six pillars and 24 priority areas.

The AuSCR is governed by a Steering Committee chaired by Professor Sandy Middleton, and a Management Committee chaired by Professor Natasha Lannin (Appendix A). The day-to-day registry operations are managed centrally by staff at the Florey Institute of Neuroscience and Mental Health (The Florey). The Data 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, and Quality Improvement Committee) provide input to registry policies and processes, education and training webinars or the secondary use of data. Members of the governance committees and subcommittees voluntarily contribute their time to ensure the rigorous operation and ongoing development of the Registry (Appendix B). The success of the AuSCR is due to the efforts of many organisations, individuals, and funding agencies (Appendix C). In particular, we acknowledge the hospital staff who contribute to the AuSCR (Appendix D), as well as the patients, their caregivers and family members, without whom the registry could not exist. We also are grateful to the experienced statistical team from Monash University, for their contributions to the analysis of AuSCR data in a de-identified format as they remain blinded to hospital names.

In 2020, the Australian Stroke Coalition (ASC) endorsed the National Excellence Awards based on acute care data submitted to the AuSCR or the national stroke audit program (managed by the Stroke Foundation). A list of award criteria, and recipients, are listed in . Publications using AuSCR data, which are used to inform policy and clinical practice, are listed in Appendix E. Nationally, the impact of the COVID-19 pandemic has been felt by AuSCR staff, participants and contributors, but most of all in Victoria. The registry successfully moved to a remote working model during the pandemic, and we are proud of the excellent response rate for 2020 in the collection of patient-reported outcomes. Against the backdrop of universal COVID-19 disruptions, this 2020 Annual report provides important highlights of the exceptional efforts of participating stroke services to collect standardised data, review their performance and strive to reduce variations in practice. For the first time our National Stroke Quality Improvement workshop, co-convened with the Stroke Foundation and Monash University, was held virtually and over 300 participants attended. We also used the data in AuSCR to inform the Victorian government of the unintended consequences of the COVID-19 pandemic which led to the preparation of two publications by a newly formed COVID-19 impacts writing group.

"Hearing what Australia is doing fills you with hope for the care of stroke patients and all the excellent work the teams are doing".
(2020 National Stroke Quality Improvement Workshop participant evaluation feedback)

Prof Sandy Middleton
(Chair, Steering Committee)

Prof Natasha Lannin
(Chair Management Committee)

Prof 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.[3]

The AuSCR adheres to the national guidelines for best-practice in clinical quality registries,[1] and can be used by public and private hospitals. Adult and paediatric episodes 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,[4] 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 AuSDaT, which is a harmonised online database platform enabling standardised and systematic data collection for multiple stroke data collection programs. The AuSDaT enables hospitals to select bundles of variables organised into data collection programs, to enable local quality of care monitoring and state and national comparisons.

AuSCR programs facilitate the collection of data for patients with stroke/TIA who are admitted to participating hospitals and also patients presenting to an Emergency Department (ED) prior to transfer for continued acute care at another hospital. This combination of programs enables the AuSCR to fully document the acute treatment pathway for patients with stroke or TIA. These programs also enable the collection of the original national minimum processes of care for assessing quality of care.[3]

In 2020, a total of seven AuSCR programs were available for participating hospitals to contribute data (Appendix G). Five programs enable data collection on eligible stroke/TIA patients who were admitted for care at participating hospitals.

The optional ED dataset enables acute data to be collected on the care provided in ED prior to transfer. The optional Fever Sugar Swallow (FeSS) dataset enables the collection of fever and blood glucose monitoring and management data to supplement data collected in other programs (Appendix H).

Staff from participating hospitals enter these data either manually via the web tool, by using a 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 data 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 patients who have not: been reported as deceased; previously refused follow-up; or opted out of the registry. For patients 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 participants living with stroke for studies (Appendix I).

The data presented in this 2020 report provide insights into the care received, and the health outcomes, for 21,512 episodes of care for 19,861 patients from 68 Australian hospitals.

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:

Support for hospital data collectors and teams

- A comprehensive data dictionary with help notes to guide data entry (consistent with the National Stroke Data Dictionary).[5]
- AuSCR training for staff at participating hospitals, completed in person or via videoconference. 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.

Database functions

- 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.

Data management activities by the AuSCR office

- Fortnightly database maintenance undertaken by Senior Data Managers, including checks for duplicate entries using patient identifiers (name, date of birth, Medicare number or hospital medical record number) and date of stroke onset, arrival, admission or discharge.
- 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. These were limited (n=3) in 2020 because of the COVID-19 pandemic.
- 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.

The ***AuSCR Annual Data Quality Report*** is a summary of data quality for the final 2020 dataset (e.g. time to record creation; data completeness; case ascertainment). A copy of this report can be obtained from the AuSCR website at https://auscr.com.au/about/annual-reports/

OVERVIEW OF DATA ANALYSIS

The data presented in this report includes information on patients who presented to an ED prior to transfer and those who were admitted to participating hospitals between 1 January and 31 December 2020. Data entry for these acute stroke/TIA episodes, and the associated follow-up questionnaires was closed off, and data extracted, on 12 October 2021. Data cleaning and analysis was undertaken by authorised Monash University statisticians.

Hospital postcodes were mapped to the Australian Statistical Geography Standard (ASGS) Remoteness Structure (2016) available from the Australian Bureau of Statistics.[6] The ASGS divides Australia into 5 classes of remoteness on the basis of a measure of relative access to services. For this report, ASGS Category 1 was defined as a Major City of Australia and ASGS Categories 2 and 3 were defined as Inner Regional and Outer Regional Australia respectively. Descriptive information about paediatric episodes (aged under 18 years) were not included in the overall patient characteristics, clinical and outcome data analyses.

As patients often receive care from >1 hospital for the same stroke/TIA event, multiple episodes relating to the same person-event were linked using a person-level identifier (a Statistical Linkage Key) and the date of stroke onset +/- 1 day. This enabled us to more accurately examine the delivery of certain processes of care across the care continuum. For example, provision of thrombolysis was calculated only for eligible episodes of ischaemic stroke where thrombolysis had not already been provided during an earlier episode of care for the same patient-event. Episodes were also excluded from the calculation of thrombolysis provision if the date and time of thrombolysis provision was before the date and time of arrival to hospital, unless there was documented evidence that thrombolysis administration was initiated in the Melbourne Mobile Stroke Unit.

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 analyses, patients who were recorded as being contraindicated were excluded from the denominator. For other time-based performance measures based on published standards such as door-to-puncture and door-to-revascularisation times were also calculated. These were calculated using dates and times of arrival to hospital and treatment. Erroneous times (e.g. negative or beyond 12 hours) were excluded from the analyses. See Appendix J for an overview of the methods used to derive quality indicators in the AuSCR.

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 mobilisation variables were also excluded where 30% of data were missing. Missing data related to Endovascular Clot Retrieval (ECR) variables were not excluded. Hospitals contributing fewer than 50 episodes of care were excluded from the funnel plots of process of care indicator data.

Benchmarks for AuSCR national indicators were calculated based on a modified version of the Achievable Benchmark of Care (ABC™) methodology[7] which has been used and validated for stroke.[8] Only hospitals that had submitted at least 50 episodes 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 of episodes reported from 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 performing hospitals from the sample of hospitals that had registered at least 50 episodes of care.

Since 2017 was the first full year we collected data in the AuSDaT, for this annual report we provide results of overall performance in a matched analysis of 47 hospitals that contributed data in each year between 2017 and 2020 (see page 23).

Follow-up survey data attempts were made between 90 and 180 days after each admission 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.

Functional disability is measured using the modified Rankin Scale (mRS) which is a standardised instrument used to categorise deficits after stroke.[9] During follow-up between 90 and 180 days post-admission, patients are asked to rate their level of functional disability across six levels: 0 (no symptoms at all; 1 (no significant disability despite symptoms); 2 (slight disability); 3 (moderate disability); 4 (moderately severe disability) and 5 (severe disability). The mRS analyses in this report exclude responses from individuals who were deceased at the time of follow-up (mRS=6).

Health-related quality of life (HRQoL) is measured in the AuSCR using the European Quality of Life measure of health status (EQ-5D™)[10], specifically the three-level version of the instrument EQ-5D-3L. The EQ-5D-3L 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). Responses to the EQ-5D-3L were dichotomised and reported based on whether patients had 'any' (i.e. moderate or extreme) versus 'no' problems with each domain.

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). Responses to the VAS were described using the mean (and standard deviation) to facilitate comparisons with published estimates for the normative population.[11] For comparisons between hospitals, mean VAS scores were adjusted to account for differences in case mix. Where possible, reference to the median (and interquartile range) was also made to assist in the interpretation of results.

Post-discharge survival is ascertained for registrants using linkage death registration data from the National Death Index. A risk adjusted mortality rate (RAMR) at 30 days post-admission was calculated for each hospital for episodes of ischaemic stroke and intracerebral haemorrhage (ICH). To ensure RAMRs, analyses were conducted for hospitals that provided ≥200 episodes of ischaemic stroke and ≥50 episodes of ICH in 2020. For hospitals with fewer episodes, data from 2019 and 2020 were pooled and used to derive RAMRs. Episodes of in-hospital stroke or transient ischaemic attack were excluded from all analyses. Similar to earlier years, RAMRs were calculated including and excluding transfers.

RAMR were calculated by 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.[12] Hospitals with risk-adjusted mortality outside the three standard deviation threshold limits were considered to have 'unwarranted variation'.

All RAMR models were adjusted for age, sex, socioeconomic position, stroke type, previous history of stroke, and a measure of stroke severity. For ischaemic stroke, we adjusted for stroke severity using the National Institutes of Health Stroke Scale (NIHSS) score. Because NIHSS scores were missing for approximately one in three episodes, multiple imputation techniques were used to assign an NIHSS score from another episode that had a similar set of patient characteristics (e.g. matched on age, sex, hospital ID, ability to walk on admission, transfer from another hospital, in-hospital stroke, and previous history of stroke). For ICH, it was not possible to adjust RAMR models using NIHSS scores as they were missing for the majority (>50%) of episodes and could not be reliably imputed. Therefore, similar to earlier years, RAMR models for ICH were adjusted for stroke severity using the ability to walk on admission (a validated measure of post-stroke outcome).[13] All analyses were performed using STATA/SE 17.0 (College Station, USA, 2021).

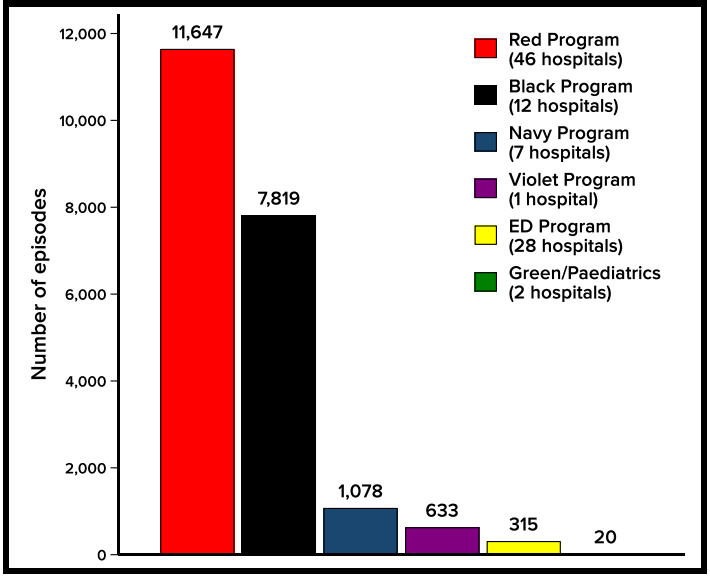
For details of the analysis for assessing the impacts of the COVID-19 pandemic see page 27.

PARTICIPATING HOSPITALS

In 2020, 68 hospitals provided data for 21,512 episodes care (Figure 1). Most hospitals participated in the Red data collection program (see Appendix H for the variables collected in each program). Data on ECR was collected by 12 hospitals as part of the Black program, and 1 hospital as part of the Violet program used in NSW.

A total of 315 episodes provided care in the ED prior to transfer were also captured in the optional ED dataset. In 2020, there were 29 hospitals located in Victoria (VIC), 22 in Queensland (QLD), eight in New South Wales (NSW), three each in Tasmania (TAS) and South Australia (SA), two in Australian Capital Territory (ACT), and one in Western Australia (WA; Table 1).

FIGURE 1: NUMBER OF EPISODES ENTERED IN 2020, BY DATA COLLECTION PROGRAM



Of the 68 hospitals, there were 37 hospitals located in a major city. Overall, 62 participating hospitals had a stroke unit and 62 provided thrombolytic therapy using intravenous tissue plasminogen activator (tPA). There were also two children's hospitals collecting AuSCR data in 2020.

Table 1: Characteristics of participating AuSCR hospitals

		HOSPITAL STATE						
	Total	***ACT***	***NSW***	***QLD***	***SA***	***TAS***	***VIC***	***WA***
Number of hospitals	68	*2*	*8*	*22*	*3*	*3*	*29*	*1*
Number of annual episodes entered in 2020*								
<75 episodes	9	*0*	*1*	*3*	*0*	*0*	*4*	*1*
75-349 episodes	38	*1*	*6*	*12*	*0*	*2*	*17*	*0*
350-499 episodes	9	*1*	*0*	*4*	*1*	*1*	*2*	*0*
≥500 episodes	12	*0*	*1*	*3*	*2*	*0*	*6*	*0*
Location#								
Major city	37	*2*	*5*	*14*	*3*	*0*	*12*	*1*
Inner Regional	23	*0*	*3*	*6*	*0*	*2*	*12*	*0*
Outer Regional	8	*0*	*0*	*2*	*0*	*1*	*5*	*0*
Stroke unit	62	*2*	*8*	*20*	*3*	*2*	*26*	*1*
Used telemedicine	45	*1*	*6*	*15*	*1*	*3*	*19*	*0*
Thrombolysis provided	62	*2*	*8*	*19*	*3*	*3*	*27*	*0*
ECR provided	13	*1*	*1*	*3*	*1*	*1*	*5*	*1*
Contributed to the ED dataset	28	*0*	*3*	*5*	*0*	*1*	*19*	*0*
Contributed to the FeSS dataset	22	*0*	*5*	*6*	*0*	*2*	*9*	*0*

ECR: endovascular clot retrieval, ED: emergency department; FeSS: Fever, sugar swallow.
*Hospital categories as per the definitions used by the Stroke Foundation of Australia acute clinical audit reports
#Location categorised using Australian Statistical Geography Standard Remoteness Structure 2016.

PATIENT CHARACTERISTICS

In 2020, there were 21,512 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 2020, there were 21,512 episodes of acute hospital care entered in the AuSCR for the 19,861 individuals registered. A total of 20,519 adult episodes of care were captured in the AuSCR in 2020.

The median number of episodes per hospital was 254 (Q1 to Q3: 125 to 432). Data from one hospital were excluded as <5 adult episodes were entered for the 2020 year. After excluding this hospital, the minimum number of episodes registered was at a metropolitan hospital in WA (n=10) and the maximum number registered was at a metropolitan hospital in VIC (n=1,322).

Table 2: Number of patients and episodes in 2020

	All episodes	Adult episodes
Number of episodes (N= 68 hospitals)	21,512	21,469
Emergency Department dataset (n= 28 hospitals)	315	313
Hospital admissions	21,197	21,156
Number of individual patients	19,861	19,818
Number of unique acute stroke/TIA events	20,562	20,519

PATIENT DEMOGRAPHICS

Table 3 provides the baseline characteristics of patients and information related to their episodes of care. Adult and paediatric episodes are presented separately. Seventeen hospitals admitted paediatric episodes (patients aged <18 years) in 2020.

Forty-four percent of all adult patients were female. The mean age of adult patients was 73 years (median: 75 years). There were 5,462 (28%) adult patients who were of working age (≤65 years), and 1,500 (8%) patients who were <50 years of age.

Information on country of birth was available for 17,717 adult patients, of whom the majority (72%) were born in Australia. The second most common place of birth was European countries excluding the UK (12%), followed by the UK (7%) and Asia (7%). The majority of the registered adult patients spoke English (91%). There were 380 adult patients (2%) who identified as having an Aboriginal or Torres Strait Islander background.

Table 3: Patient characteristics (adults and paediatric episodes)

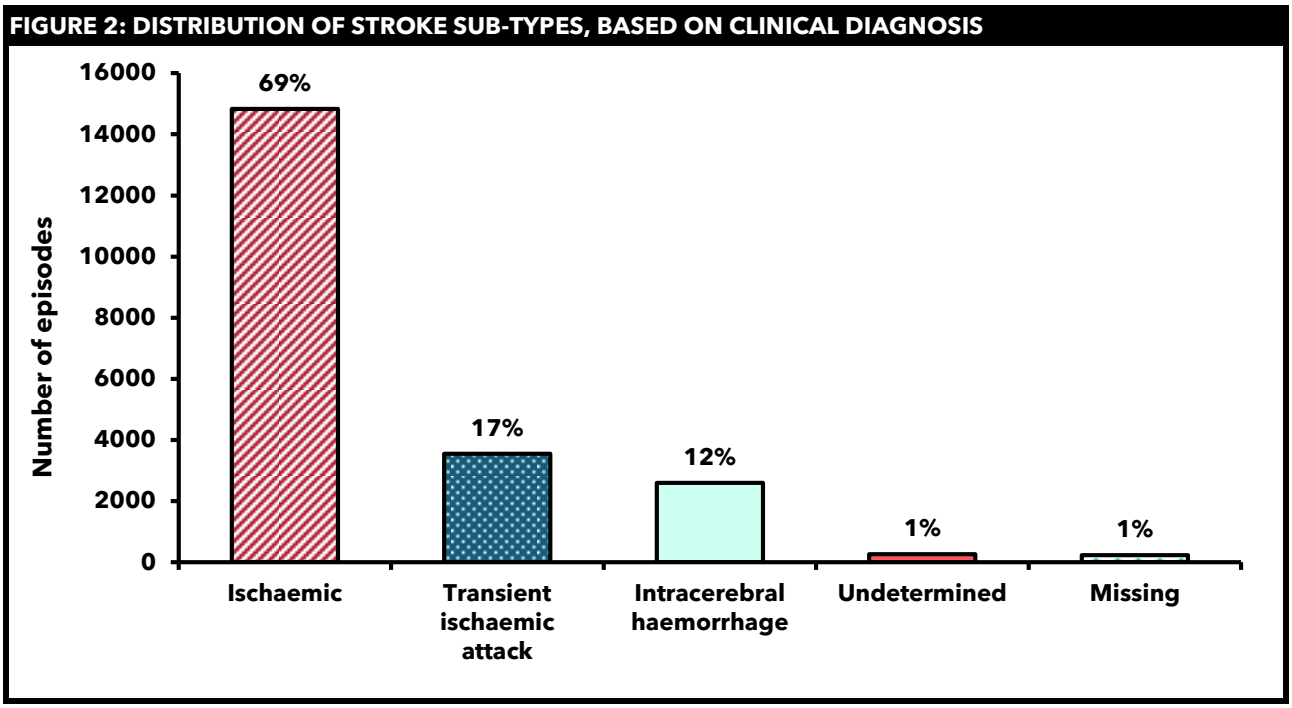
Patients	Adults (n=19,818)	Paediatrics (n=43)
Episodes (N = 21,512)	**21,469**	**43**
Age in years, mean (SD)	73 (14)	8 (7)
Age in years, median (Q1 to Q3)	75 (64 to 83)	8 (0 to 16)
Female, n (%)	8,594 (44)	16 (37)
Place of birth, n (%)		
Australia	12,802 (72)	39 (98)
United Kingdom	1,172 (7)	0 (0)
Other European counties	2,035 (12)	0 (0)
North Africa/Middle East	242 (1)	0 (0)
Asia	1,211 (7)	<5 (<10%)
Rest of Africa	205 (1)	0 (0)
Others	10 (0)	0 (0)
Aboriginal and/or Torres Strait Islander, n (%)	380 (2)	<5 (<10%)
English spoken, n (%)	15,292 (91)	34 (92)

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

CLINICAL DIAGNOSES

Of the 21,469 adult episodes, clinicians indicated that there were 14,830 ischaemic strokes, 2,597 intracerebral haemorrhages (ICH), 3,546 TIAs and 263 episodes of undetermined stroke type. There were 233 episodes (0.9%) where the stroke type was missing (Figure 2). It is reassuring that the assignment of undetermined stroke type has decreased over the years (i.e. in 2017 it was 2.5%, p <0.001). Of the 496 episodes with missing or undetermined stroke type for clinical diagnosis, ICD-10 codes were provided for 318, which comprised ischaemic stroke (n=97), ICH (n=13), undetermined (n=153) and TIA (n=55).

FIGURE 2: DISTRIBUTION OF STROKE SUB-TYPES, BASED ON CLINICAL DIAGNOSIS



STROKE SEVERITY

In the AuSCR we have two variables we can use to provide an indication of severity at time of arrival to hospital. The patients' ability to walk on admission was recorded in 20,154 episodes (94% of the 2020 cohort), of which 43% were documented as having been able to walk on admission. A National Institutes of Health Stroke Scale (NIHSS) score at the time of presentation to hospital was recorded for 12,855 episodes (60% of the 2020 cohort), of which 7% had a severe stroke (NIHSS ≥21).

Patients with a diagnosis of ischaemic stroke had the lowest proportion of missing NIHSS scores (34%). There were 10 episodes (4%) with a missing clinical diagnosis for which a NIHSS score was recorded.

Of the episodes receiving thrombolysis, a NIHSS score was missing for 8%. Episodes treated in a stroke unit had a greater proportion of NIHSS scores recorded than those treated in alternate ward settings (67% vs 40%, $p<0.001$). Excluding those with TIA, there were 10,555 episodes with data for both of the stroke severity variables recorded (Table 4). The greatest proportion of patients who were not able to walk on admission had a NIHSS score between five and 15, indicating a moderate stroke (43%). Of those who were able to walk on admission, the majority (59%) had a NIHSS score of one to four, 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)	228 (3)	651 (16)
Minor stroke (1-4)	1,865 (28)	2,361 (59)
Moderate stroke (5-15)	2,862 (43)	801 (20)
Moderate to severe stroke (16-20)	800 (12)	90 (2)
Severe stroke (21-42)	831 (13)	66 (2)
Total, N	**6,586**	**3,969**

Excludes episodes of transient ischaemic attack.

IN-PATIENT STROKES

There were 850 episodes (4%) that occurred while patients were already in hospital for another condition. The proportion of in-patient strokes varied from 0% to 7% between hospitals. The majority of the inpatient episodes were ischaemic (n=690, 81%) and the largest proportion of inpatient strokes (n=254, 31%) occurred among patients aged between 75 and 84 years.

ARRIVAL WITHIN 4.5 HOURS OF SYMPTOM ONSET

For episodes with a date and time of stroke onset and arrival to hospital (N=19,061), 8538 (45%) arrived to hospital within 4.5 hours of symptom onset. A smaller proportion of patients with ischaemic stroke (41%) arrived to hospital within 4.5 hours of symptom onset compared to episodes of ICH (44%), undetermined stroke (44%), or TIA (61%; $p<0.001$).

ARRIVAL BY AMBULANCE

Method of arrival to the ED was collected for 20,251 episodes. Of these, 15,759 (78%) were transported by ambulance. A greater proportion of patients who arrived by ambulance arrived within 4.5 hours of symptom onset than those patients who arrived by other modes of transport (49% vs 30%, $p<0.001$). The proportion of patients who arrived by ambulance was smallest for TIAs (72%), and greatest for ICH (83%).

ACUTE CARE DATA

PATIENT TRANSFERS

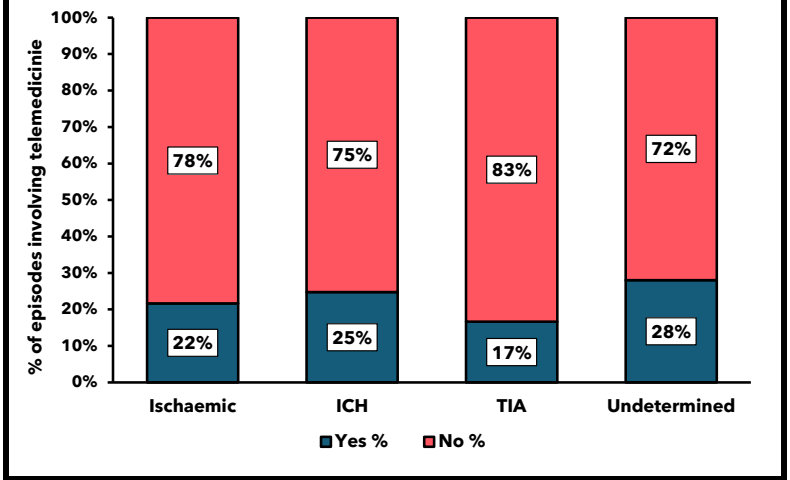
There were 3392 episodes (16%) where patients were transferred from another hospital. Of these, 807 were transferred from another hospital participating in the AuSCR and both episodes were recorded in the AuSCR. The majority (79%) of patients who were transferred from another hospital arrived by ambulance. The reason for transfer was collected for hospitals participating in the AuSCR Black and Violet data collection programs (49% of transferred episodes in 2020; Appendix G). Transfer for thrombolysis was indicated for 44 patients (13 ACT; 12 SA; 11 QLD; 7 VIC; 1 TAS) and transfer for ECR was indicated for 909 patients (498 VIC; 246 QLD; 83 SA; 39 NSW; 34 ACT; 6 TAS).

INVOLVEMENT OF TELEMEDICINE IN ACUTE STROKE CARE

Excluding metropolitan hospitals participating in the AuSCR Black or Violet programs, telemedicine consultations were provided at 45 hospitals (19 VIC; 15 QLD; 6 NSW; 3 TAS; 1 SA; and 1 ACT). A total of 2700 episodes involved telemedicine at these hospitals (70% of episodes in ACT, 34% in TAS, 25% in VIC, 17% in QLD, 16% in NSW, 5% in SA).

There were 1862 episodes of ischaemic stroke involving a telemedicine consultation (Figure 3). Of these, thrombolysis was administered in 360 episodes (19%). The median door-to-needle time for these episodes was 94 minutes (Q1 to Q3: 67 to 123).

FIGURE 3: CLINICAL DIAGNOSIS OF PATIENTS PROVIDED WITH A TELEMEDICINE CONSULTATION



ICH: intracerebral haemorrhage; TIA: transient ischaemic attack

BRAIN SCANS

Excluding data from hospitals with >30% missing information on the provision of brain scans (n=5 hospitals; 1697 episodes), there was evidence that 99% of adult episodes were provided a brain scan in 2020. Fewer episodes of undetermined stroke received a brain scan (95%) compared to other stroke types (>99%). Of those who received a brain scan, there were 19,173 episodes where a date and time of the brain scan was recorded. Of these, 1376 episodes received a brain scan prior to transfer to the hospital at which they were admitted. For episodes provided a brain scan after arrival to hospital, the median time to scan was 44 minutes, with six hospitals achieving a median time ≤25 minutes (Figure 4). The median time to brain scan after arrival to hospital was 29 minutes for patients with ischaemic stroke who arrived within 4.5 hours of symptom onset (Figure 5).

FIGURE 4: MEDIAN DOOR-TO-SCAN TIME, BY HOSPITAL

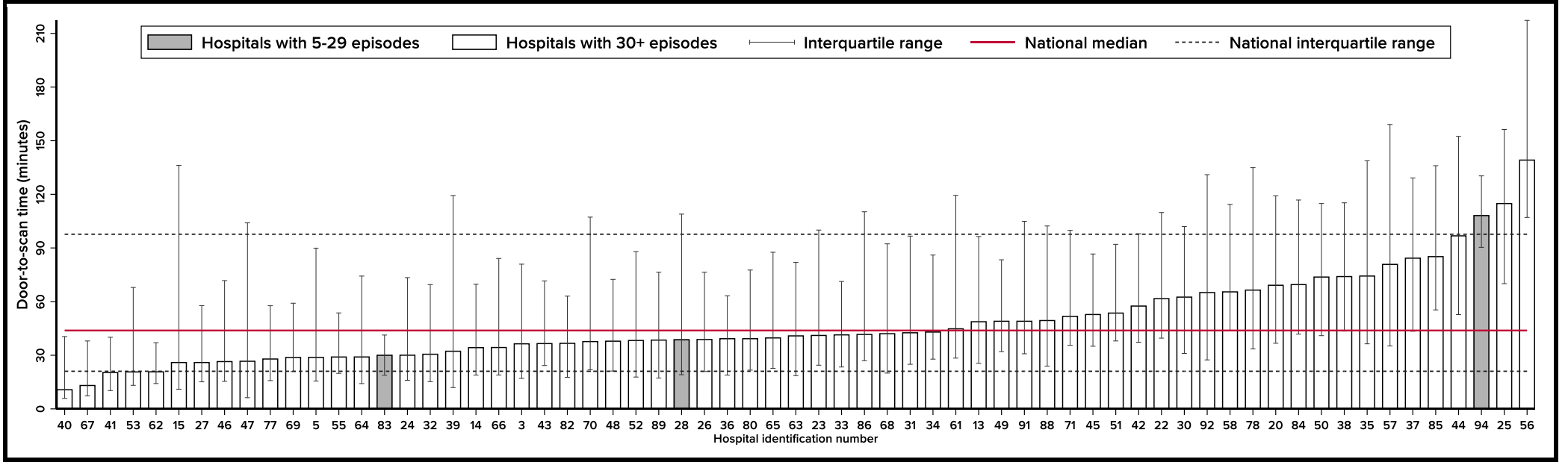
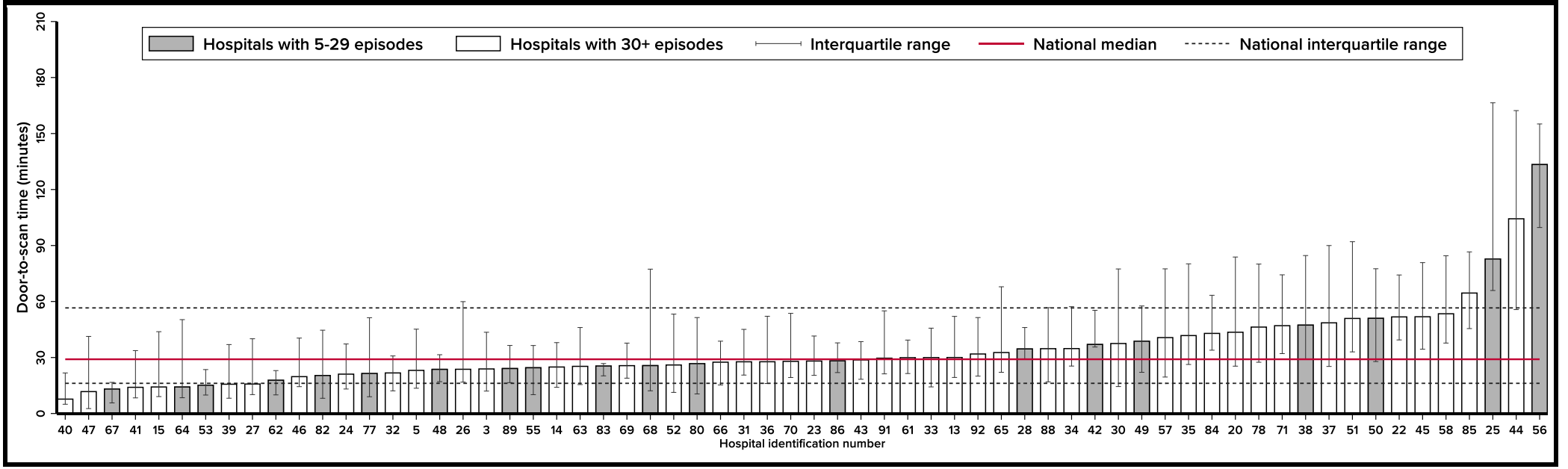


FIGURE 5: MEDIAN DOOR-TO-SCAN TIME FOR ISCHAEMIC STROKES PRESENTING WITHIN 4.5 HOURS, BY HOSPITAL



Excludes data from 1 hospital with <5 episodes as well as episodes where a brain scan was provided after 270 minutes of arrival.
Number of episodes with door-to-scan times by hospital range from 7 to 963 in Figure 4, and 5 to 446 in Figure 5.

OVERALL ADHERENCE TO QUALITY INDICATORS

THROMBOLYSIS TREATMENT DELIVERY

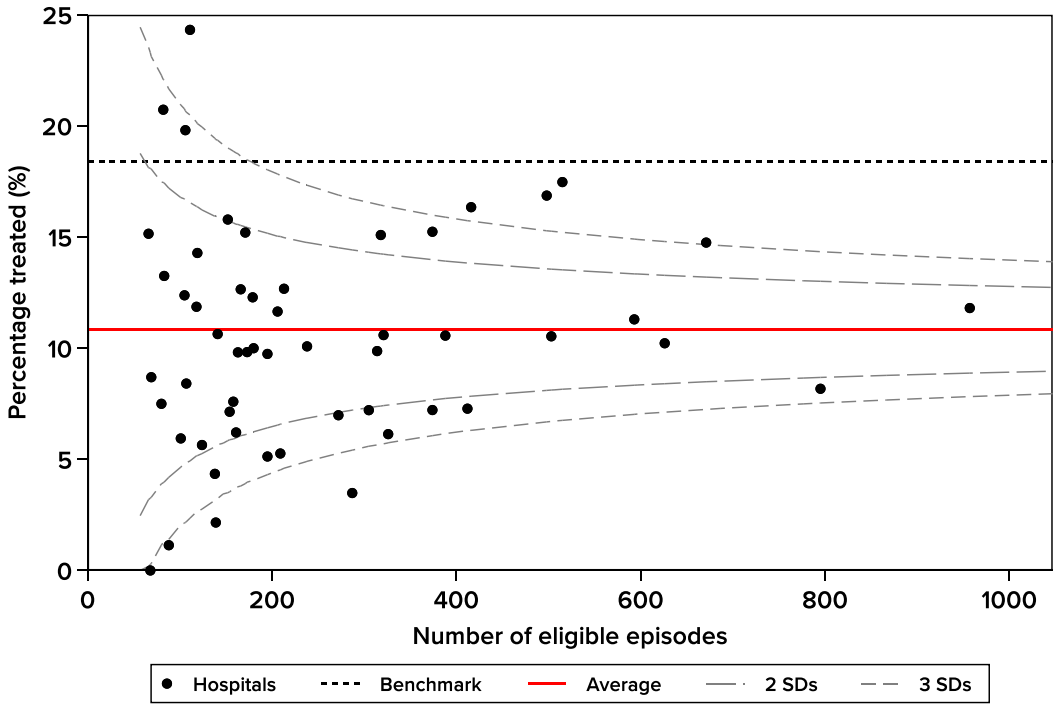
Of the eligible episodes of ischaemic stroke (N=14,309), 1,569 (11%) were provided with intravenous thrombolysis treatment (Figure 6). Of these, 152 episodes received thrombolysis for the first time after transfer from another hospital. Overall provision of thrombolysis was similar by state: VIC (12%), QLD (11%), NSW (10%), ACT (10%), SA (10%), TAS (10%; *p*=0.15).

Provision of thrombolysis was similar between hospitals located in major cities (11%) compared to those located in inner regional (10%) or outer regional Australia (9%; *p*=0.13). However, hospitals providing ECR had greater provision of thrombolysis (12%) compared to hospitals that did not offer this therapy (10%; *p*=0.007).

Of the 5,251 eligible patients with ischaemic stroke who arrived within 4.5 hours of symptom onset, 26% were provided with intravenous thrombolysis. Of the 1,538 episodes with a date and time recorded for the provision of thrombolysis that was not administered prior to hospital arrival, 31% had a door-to-needle time under 60 minutes. The median door-to-needle time was 75 minutes and median onset-to-needle time was 156 minutes. There was no difference in the median onset-to-needle time between patients who were directly admitted and those transferred from another hospital (158 vs 154 minutes; *p*=0.17). For those provided with thrombolysis, the median door-to-scan time was 22 minutes.

FIGURE 6: RECEIVED INTRAVENOUS THROMBOLYSIS, BY HOSPITAL

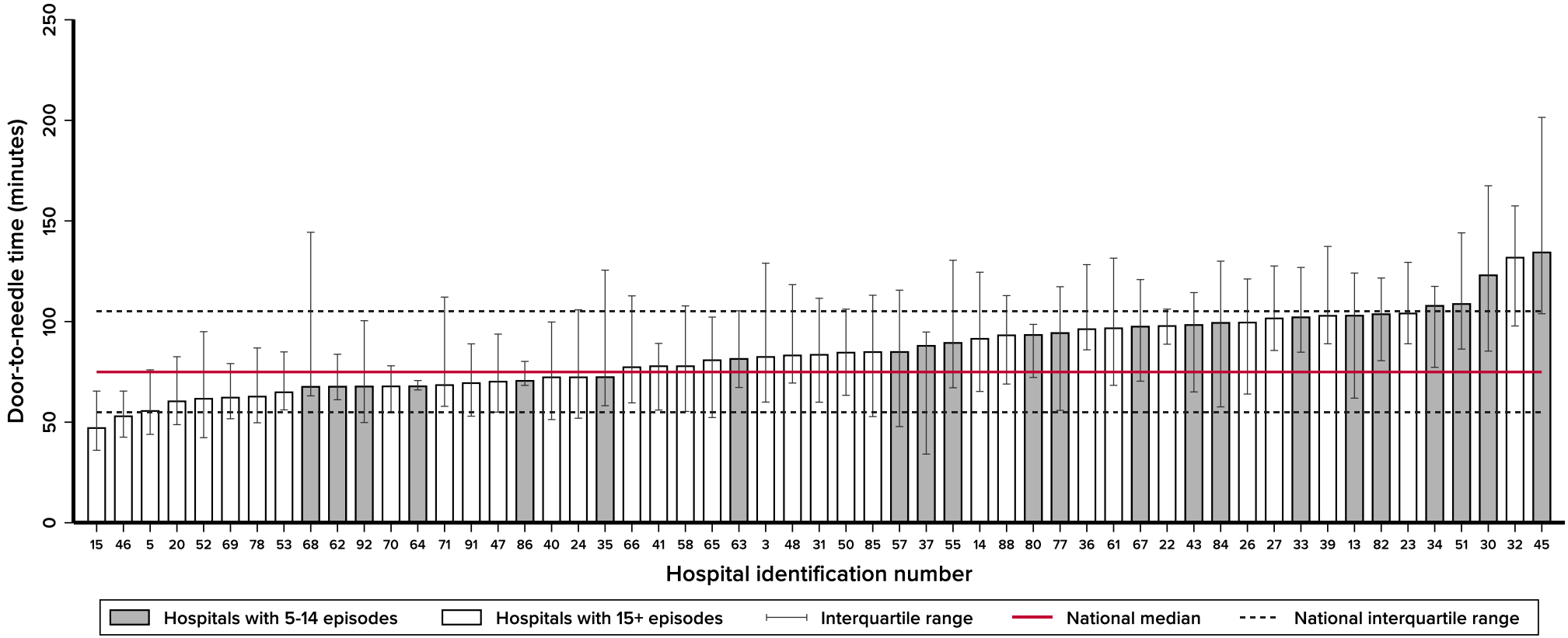
ACHIEVABLE BENCHMARK*†: 18% **AVERAGE ADHERENCE†: 11%**



Each dot represents the mean adherence for an individual hospital.
** Benchmark based on a modified ABC™ method using data from sites with at least 50 eligible episodes.*
† Excludes episodes of ischaemic stroke where thrombolysis had already been provided prior to arrival to hospital, unless there was documented evidence that thrombolysis administration was initiated in a mobile stroke unit.

At the individual hospital level, only three hospitals had a median door-to-needle time of 60 minutes or less (Figure 7). Patients who were treated in an inner or outer regional hospital were less likely to have a door-to-needle time under 60 minutes compared to patients treated at a metropolitan hospital (18% vs 35%; $p<0.001$).

FIGURE 7: DOOR-TO-NEEDLE TIMES, BY HOSPITAL



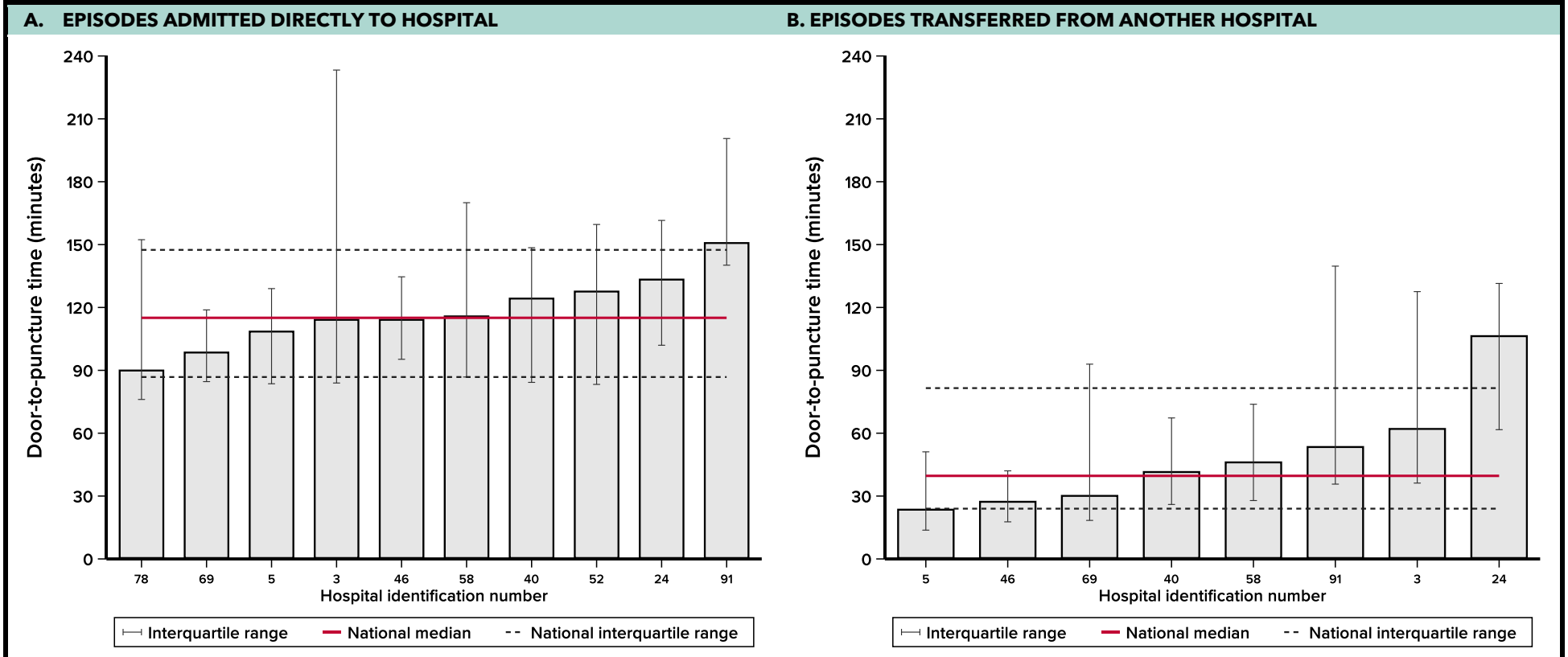
Excludes episodes where thrombolysis was provided prior to arrival or after 270 minutes of arrival.
Number of episodes with door-to-needle times by hospital range from 5 to 109.
Excludes data from 11 hospitals with <5 episodes.

ENDOVASCULAR CLOT RETRIEVAL (ECR)

Among the 13 hospitals participating in the AuSCR Black or Violet (NSW only) programs in 2020 (5 in VIC, 3 in QLD, and 1 each in ACT, NSW, SA, TAS, WA), 1263 episodes of ischaemic stroke (20%) were provided ECR. The achievable benchmark for ECR (if an ischaemic stroke) was 29% among these hospitals in 2020. For episodes where times of both arrival and treatment were collected, the median time from arrival to groin puncture was 91 minutes (Q1 to Q3: 42 to 131 minutes).

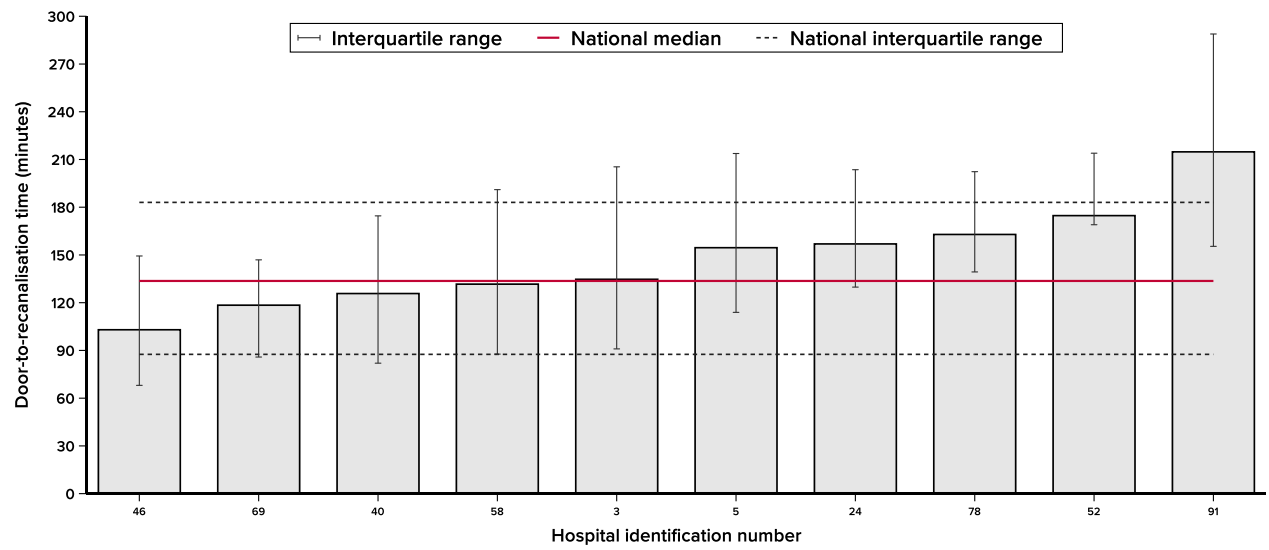
For episodes transferred from another hospital, the median time from arrival to groin puncture was 75 minutes faster when compared to direct admissions (40 minutes vs 115 minutes; $p<0.001$; Figure 8). It was interesting to note, the median onset to groin puncture time was significantly longer for transferred patients at 320 minutes compared to 213 minutes for direct admissions ($p<0.001$). The median time from arrival to recanalisation time was 134 minutes (Figure 9).

FIGURE 8: DOOR-TO-PUNCTURE TIME FOR EPISODES ADMITTED DIRECTLY OR VIA TRANSFER, BY HOSPITAL



Includes data only from hospitals participating in the AuSCR Black or Violet data collection programs.
Excludes data from hospitals with <15 episodes and episodes with invalid door-to-puncture times (i.e. negative or greater than 720 minutes).
Number of episodes with door-to- puncture time by hospital ranged from 25 to 91 in panel A; and from 29 to 163 in panel B.

FIGURE 9: DOOR-TO-RECANALISATION TIME FOR EPISODES PROVIDED ECR, BY HOSPITAL



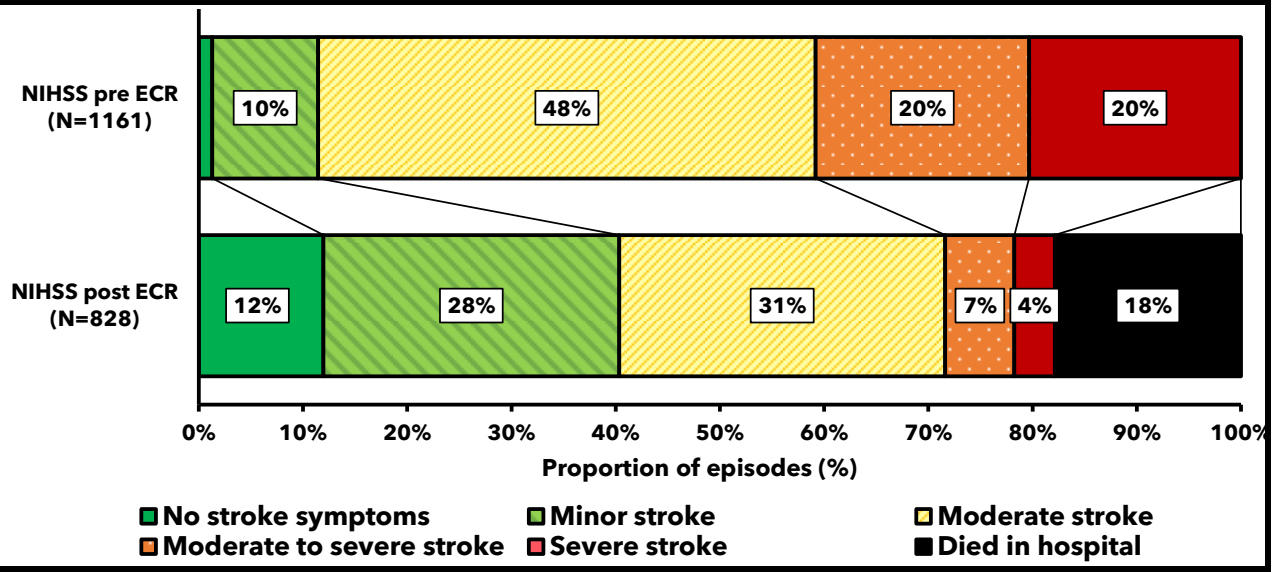
Includes data only from hospitals participating in the AuSCR Black or Violet data collection programs. Excludes data from hospitals with <15 episodes and episodes with invalid door-to-puncture times (i.e. negative or greater than 720 minutes). Number of episodes with door-to-puncture time by hospital range from 20 to 220.

National Institutes of Health Stroke Scale: before and after ECR

Stroke severity is able to be objectively assessed using the National Institutes of Health Stroke Scale (NIHSS). The NIHSS score is also used to assess eligibility for some treatments, as well as to examine the effectiveness 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. Of the 1,263 patients provided with ECR, 1,161 had a NIHSS score pre-ECR recorded (92% complete) and 828 had a NIHSS score post-ECR recorded or were recorded as having died while in hospital (66% complete). A summary of NIHSS scores before and after ECR is provided in Figure 10.

FIGURE 10: NIHSS SCORES BEFORE AND AFTER ECR

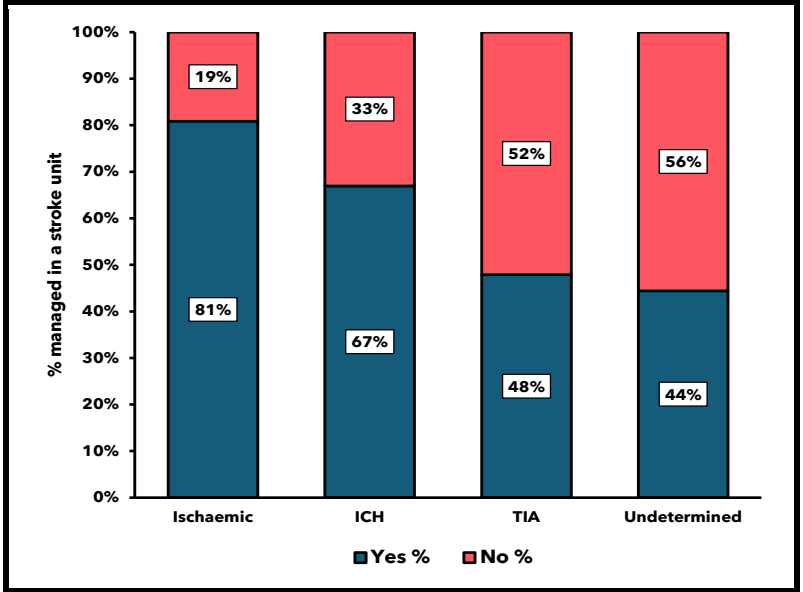


NIHSS 0: No stroke symptoms; NIHSS 1-4: Minor stroke; NIHSS 5-15: Moderate stroke; NIHSS 16-20: Moderate to severe stroke; NIHSS 21-42: Severe stroke

STROKE UNIT CARE

Approximately three quarters of all episodes (73%) were treated in a stroke unit. Of the patients with ischaemic stroke, 81% were treated in a stroke unit, compared to 67% of those with ICH, 48% of those with TIA and 44% of those with undetermined stroke type (Figure 11). Patients who experienced a stroke or TIA while already in hospital for a different condition (i.e. an in-patient episode) were treated in a stroke unit less often than those who presented from the community (53% vs 74%, $p<0.001$). There were fifteen hospitals that provided stroke unit care to ≥90% of patient episodes in 2020 (Figure 12).

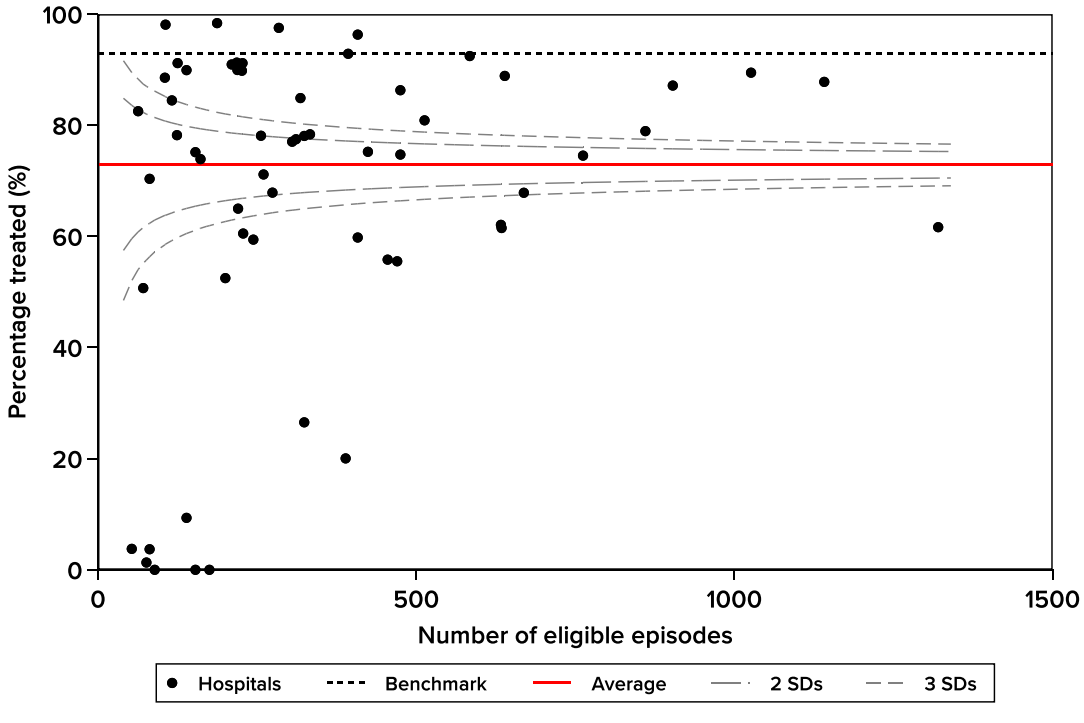
FIGURE 11: TREATED IN A STROKE UNIT, BY DIAGNOSIS



ICH: intracerebral haemorrhage; TIA: transient ischaemic attack

FIGURE 12: TREATMENT IN A STROKE UNIT, BY HOSPITAL

ACHIEVABLE BENCHMARK*†: 93% **AVERAGE ADHERENCE†: 73%**



Each dot represents the mean adherence for an individual hospital.
** Benchmark based on a modified ABC™ method using data from sites with at least 50 eligible episodes.*
† Excludes ED episodes

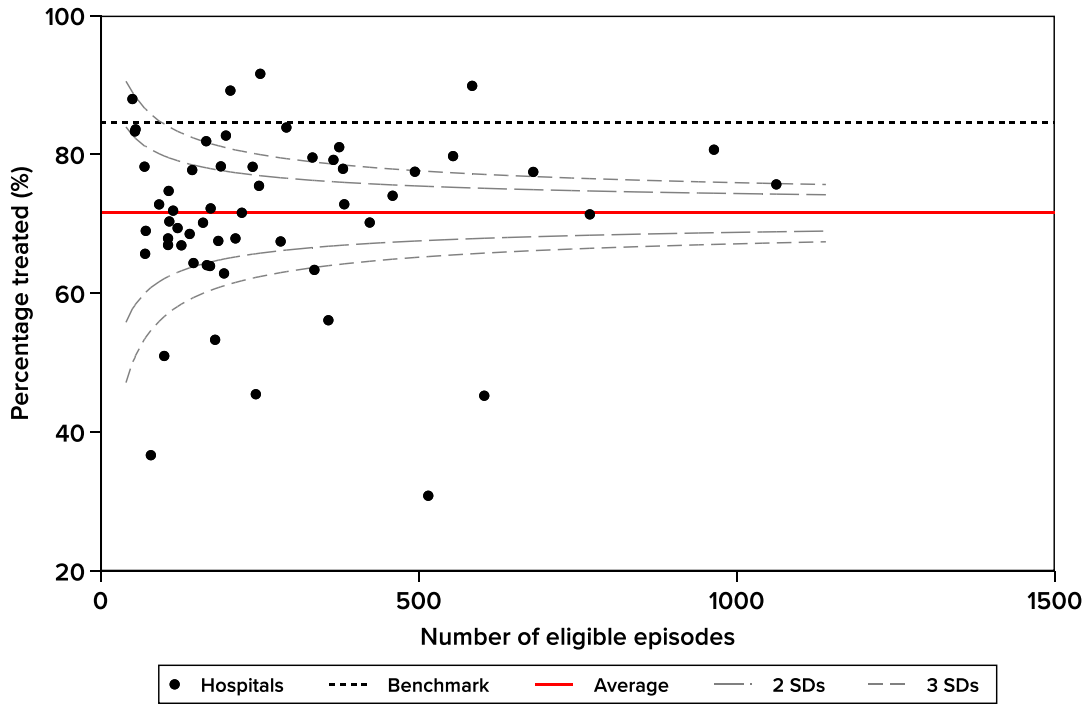
OTHER ACUTE ASSESSMENT AND MANAGEMENT PRACTICES

HYPERACUTE ANTITHROMBOTIC THERAPY

To accommodate the changes in national clinical guidelines,[14] we report the hyperacute provision of any antithrombotic agent, instead of the provision of an antiplatelet agent only. After excluding episodes of intracerebral haemorrhage and those with documented contraindications, hyperacute antithrombotic therapy was provided within 48 hours of stroke onset in 72% of episodes (Figure 13).

FIGURE 13: HYPERACUTE ANTITHROMBOTIC THERAPY, BY HOSPITAL

ACHIEVABLE BENCHMARK*†: 85% **AVERAGE ADHERENCE†: 72%**



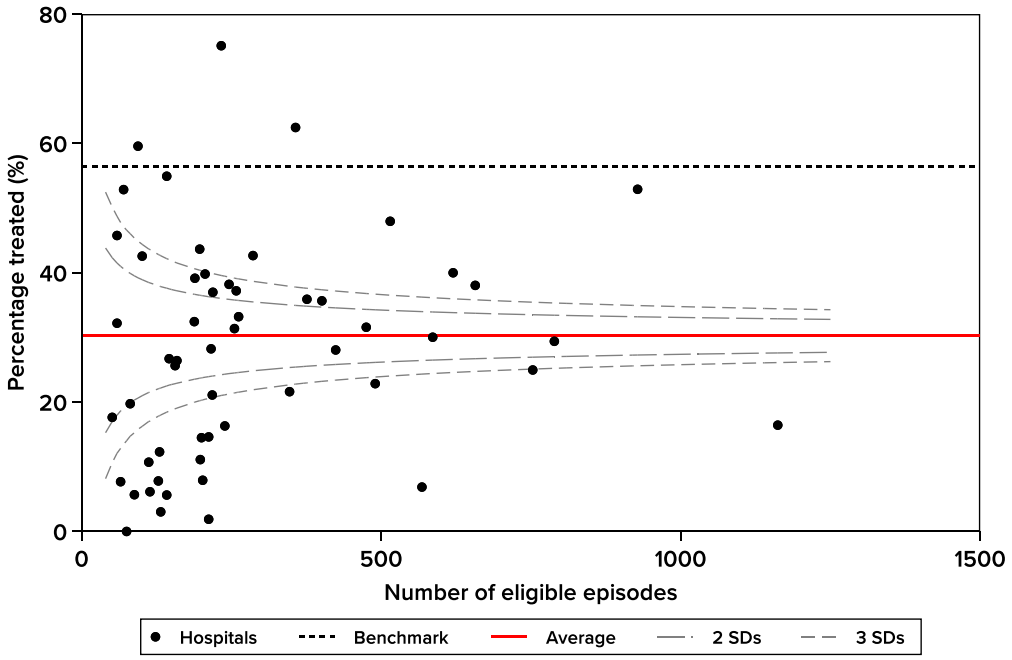
Each dot represents the mean adherence for an individual hospital.
** Benchmark based on a modified ABC™ method using data from sites with at least 50 eligible episodes.*
† Excludes episodes of intracerebral haemorrhage, episodes with contraindications, and ED episodes.

SWALLOW SCREEN AND ASSESSMENT

A swallow screen was undertaken in approximately half (57%) of all episodes, whereas a formal swallow assessment conducted by a speech pathologist was completed in 68% of episodes in 2020 (Figure 14 and Figure 15). Overall, a swallow screen or assessment was conducted within four hours of arrival to hospital for 30% of episodes, and within 24 hours for 69% of all episodes. A swallow screen or assessment occurred *prior* to oral intake in 58% of episodes.

FIGURE 14: SWALLOW SCREEN OR ASSESSMENT WITHIN 4 HOURS OF ARRIVAL, BY HOSPITAL

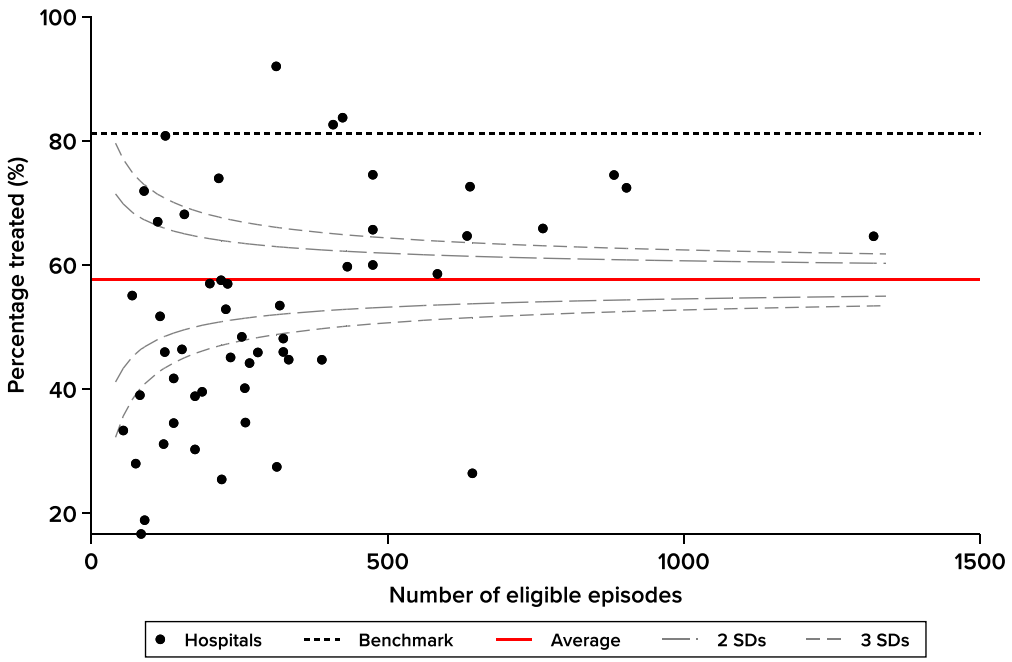
ACHIEVABLE BENCHMARK*: 56% **AVERAGE ADHERENCE*: 30%**



Each dot represents the mean adherence for an individual hospital.
** Benchmark based on a modified ABC™ method using data from sites with at least 50 eligible episodes*

FIGURE 15: SCREEN OR ASSESSMENT PRIOR TO ORAL INTAKE, BY HOSPITAL

ACHIEVABLE BENCHMARK*: 81% **AVERAGE ADHERENCE*: 58%**



Each dot represents the mean adherence for an individual hospital.
** Benchmark based on a modified ABC™ method using data from sites with at least 50 eligible episodes.*

MOBILISATION

Of the episodes submitted from hospitals participating in either the AuSCR Red or Black programs (N=17,030, 86% were mobilised during their admission, with the majority of patients (72%) mobilised on the same day, or the day after, arrival to hospital (Figure 16). Patients with ICH were less likely to be mobilised on the same day, or day after arrival, than other clinical diagnoses (Table 5)

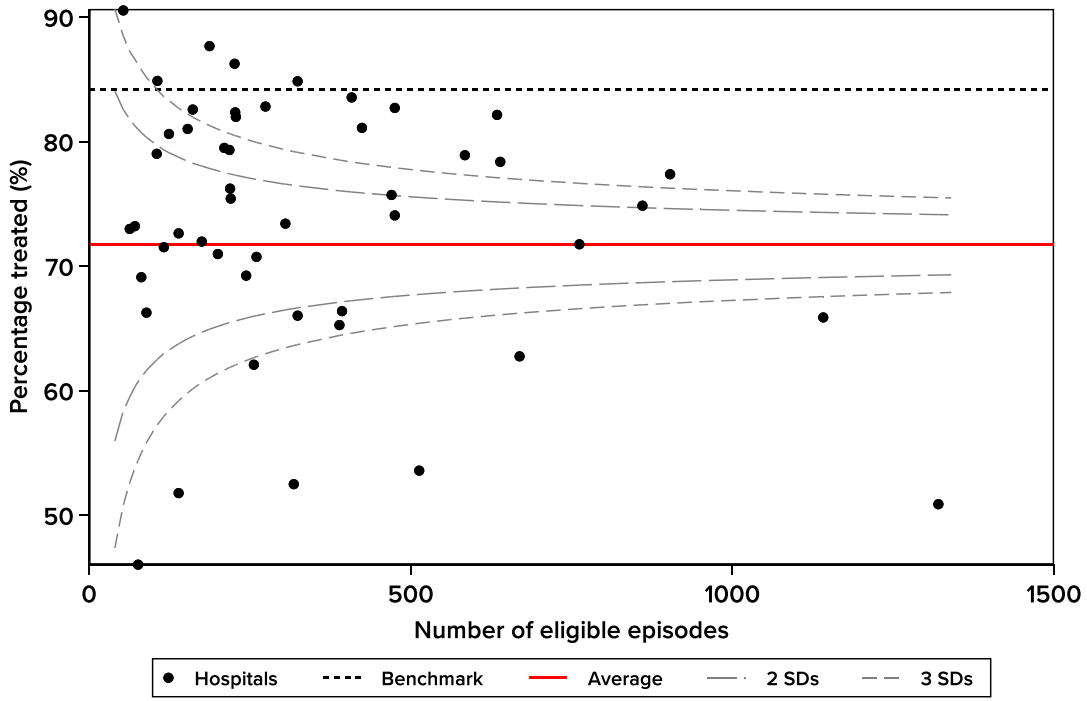
MONITORING AND MANAGEMENT OF FEVER AND BLOOD GLUCOSE

In 2020, 22 hospitals contributed a total of 2,470 episodes to the FeSS dataset (median of 84 episodes per hospital; min-max: 1-466). The FeSS dataset included the documentation of fever and hyperglycaemia in addition to swallow screen/assessment (Appendix H). Temperatures were recorded ≥4 times on the day of admission for 85% of episodes (Table 6). Of the 282 episodes with a fever (temperature ≥37.5°C) recorded within 72 hours of admission, 34% were administered paracetamol.

The majority (61%) of the 2470 episodes with FeSS data available had blood glucose levels recorded at least 4 times on the first day of the ward admission. A total of 475 (19%) episodes recorded blood glucose levels above 10mmols/L within 48 hours of admission. Of these, 27% were administered insulin within the first hour of the measured elevation.

FIGURE 16: MOBILISATION SAME DAY OR DAY AFTER, BY HOSPITAL

ACHIEVABLE BENCHMARK*†: 84% **AVERAGE ADHERENCE†: 72%**



Each dot represents the mean adherence for an individual hospital.
** Benchmark based on a modified ABC™ method using data from sites with at least 50 eligible episodes.*
† Excludes episodes submitted to the AuSCR Green, Violet, Navy or ED programs.

Table 5: Stroke evaluation and therapy

Hospital stroke care	All episodes	Ischaemic	ICH	TIA	UND.
Antithrombotic therapy within 48 hours of stroke onset*	72%	70%	-	80%	60%
Mobilised during episode	86%	89%	66%	92%	83%
Mobilised same day or day after arrival	72%	73%	43%	88%	70%
If unable to walk on admission, patient mobilised during episode	81%	85%	59%	90%	74%
If unable to walk on admission, mobilised same day or day after arrival	61%	65%	35%	82%	61%
Swallow screen conducted	57%	62%	43%	48%	46%
Screened within 4 hours	26%	28%	19%	24%	20%
Screened within 24 hours	52%	56%	39%	45%	41%
Swallow assessment conducted	68%	76%	61%	46%	54%
Assessed within 4 hours	7%	7%	5%	6%	8%
Assessed within 24 hours	42%	47%	33%	32%	33%
Swallow screen or assessment within 4 hours	30%	33%	22%	27%	24%
Swallow screen or assessment within 24 hours	69%	75%	54%	59%	56%
Swallow screen or assessment prior to oral intake	58%	63%	55%	41%	40%

ICH: intracerebral haemorrhage; TIA: transient ischaemic attack; UND.: undetermined stroke type.
* Excludes intracerebral haemorrhage and episodes with documented contraindications.

Table 6: Monitoring and management of fever and blood glucose

Fever and Blood Glucose	All episodes
	N=2,470
Temperature recorded ≥4 times on day one of ward admission	85%
Patient developed a fever of ≥37.5C in the first 72 hours following admission	11%
Where fever was present, paracetamol was administered within 1 hour of the first elevated temperature measurement*	34%
Finger prick blood glucose documented ≥4 times on day 1 of ward admission	61%
Patient developed blood glucose level above 10mmols/L within 48 hours of admission	19%
Where patient developed blood glucose level above 10mmols/L, insulin was administered within the first hour of elevated blood glucose measurement	27%

* Excludes episodes with contraindications (or if paracetamol was previously administered).

DISCHARGE MEDICATIONS

Overall, among those alive at discharge, 75% were discharged on an antihypertensive medication (Figure 17). In those with an ICH, 79% were discharged on an antihypertensive medication (Table 7). Excluding episodes of ICH, antithrombotic medications were prescribed at discharge for 93% of all episodes (Figure 18), and lipid-lowering medications were prescribed for 81% (Figure 19).

Of the patients with ischaemic stroke, 64% were discharged on a combination of antihypertensive, antithrombotic and lipid-lowering medications. Patients aged ≥75 years were more likely to be prescribed all three medications at discharge than those aged younger (64% vs 60%; $p<0.001$). Men were also more likely to receive all three medications than women (64% versus 60%; $p<0.001$).

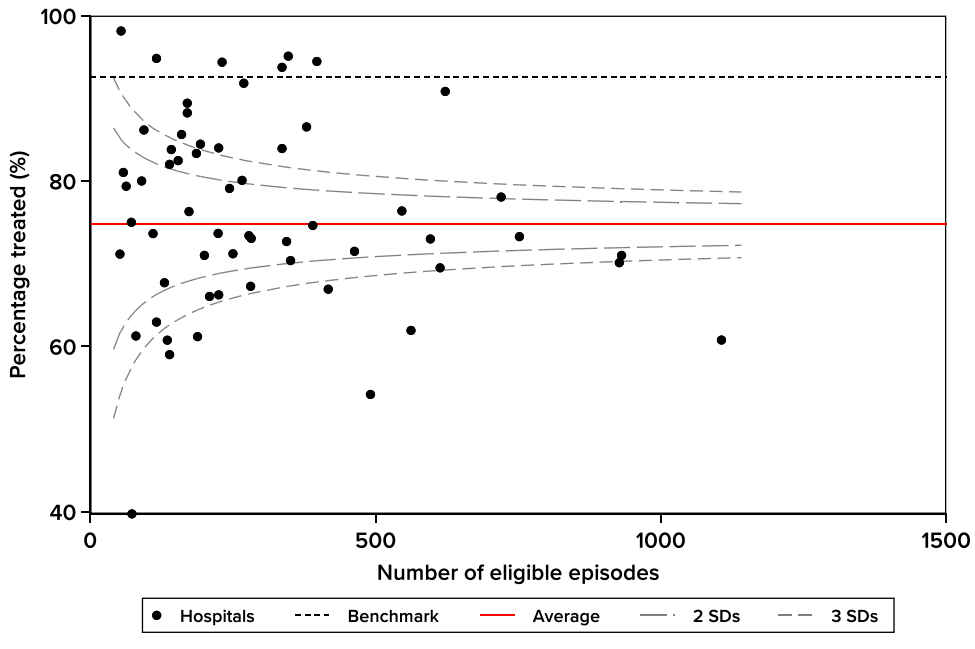
Table 7: Discharge medications, by clinical diagnosis

Medication on discharge	All episodes	Ischaemic	ICH	TIA
Discharged on an antihypertensive medication*	75%	77%	79%	69%
Discharged on an antithrombotic medication*	93%	94%	N/A	92%
Discharged on a lipid-lowering medication*	81%	82%	N/A	80%
Discharged on a combination of secondary prevention medications*†	62%	64%	N/A	59%

ICH: intracerebral haemorrhage; N/A: Not applicable; TIA: transient ischaemic attack.
** Excludes episodes with documented contraindications, in-hospital deaths and episodes recorded in the ED dataset.*
† A combination of antihypertensive, antithrombotic and lipid-lowering medications.

FIGURE 17: DISCHARGED ON ANTIHYPERTENSIVE MEDICATIONS, BY HOSPITAL

ACHIEVABLE BENCHMARK*†: 93% **AVERAGE ADHERENCE†: 75%**



Each dot represents the mean adherence for an individual hospital.
** Benchmarks based on a modified ABC™ method using data from sites with at least 50 eligible episodes.*
† Excludes episodes with documented contraindications, episodes resulting in death while in hospital, and ED episodes.

FIGURE 18: DISCHARGED ON ANTITHROMBOTIC MEDICATIONS, BY HOSPITAL

ACHIEVABLE BENCHMARK*†‡: 99% **AVERAGE ADHERENCE†‡: 93%**

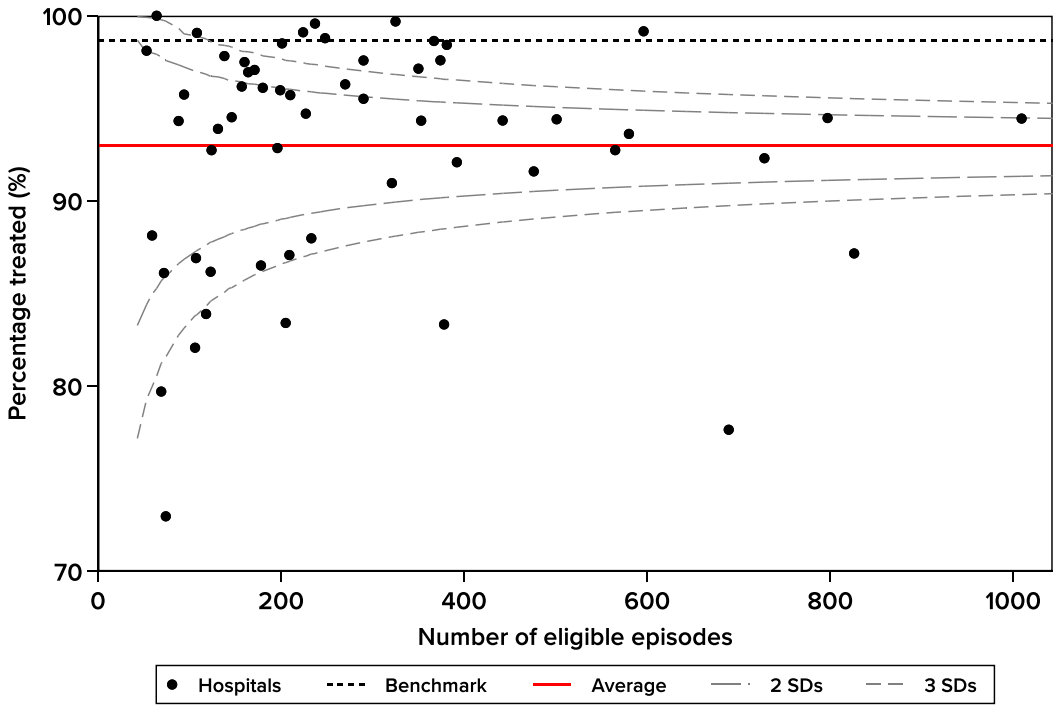
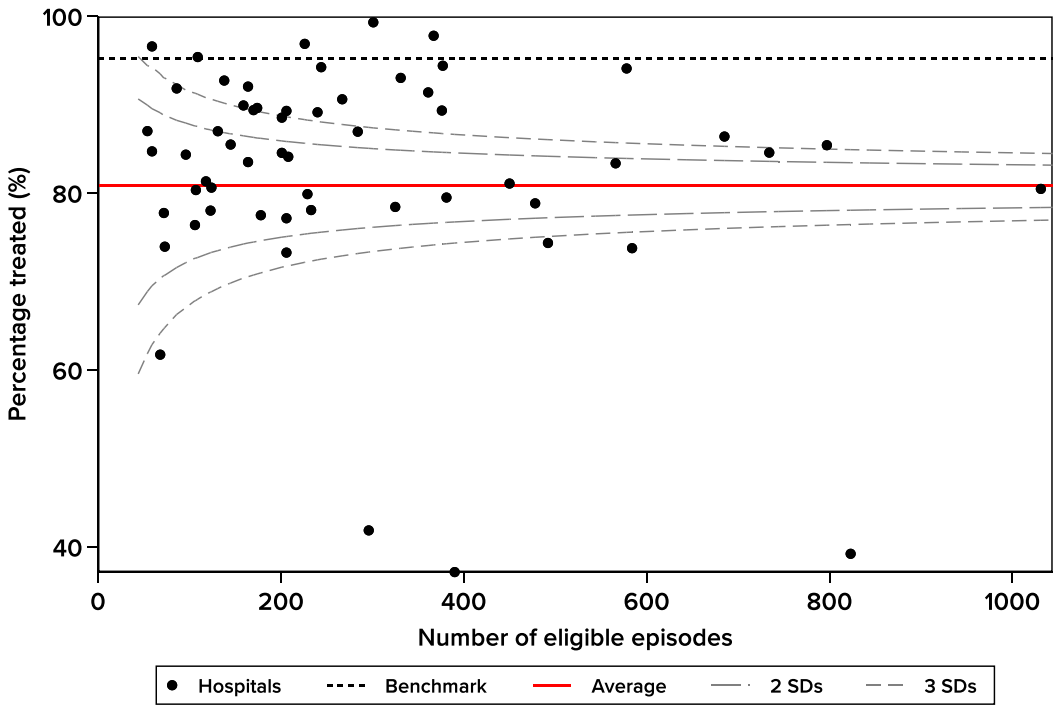


FIGURE 19: DISCHARGED ON LIPID-LOWERING MEDICATIONS, BY HOSPITAL

ACHIEVABLE BENCHMARK*†: 95% **AVERAGE ADHERENCE†: 81%**



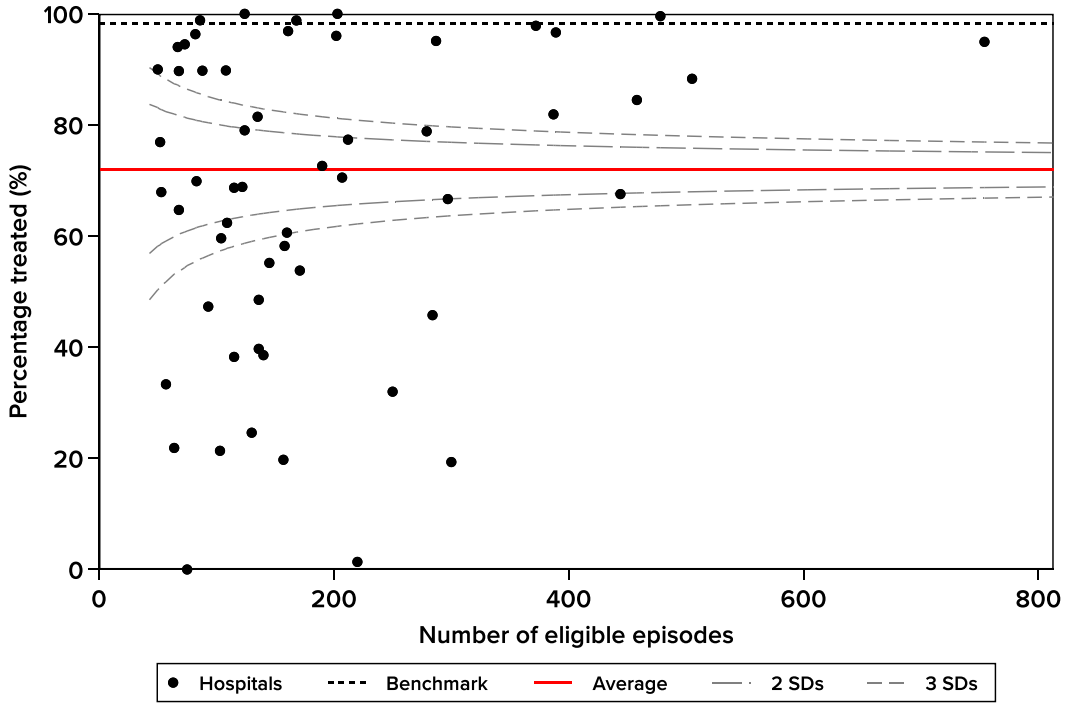
Each dot represents the mean adherence for an individual hospital.
** Benchmarks based on a modified ABC™ method using data from sites with at least 50 eligible episodes.*
† Excludes episodes of intracerebral haemorrhage, episodes with documented contraindications, episodes resulting in death while in hospital, and ED episodes.

TRANSITION FROM HOSPITAL CARE

Among the 10,861 episodes resulting in discharge home or to a residential aged care facility, 72% received a care plan outlining post-discharge care in the community that was developed with the patient or family (Figure 20). Of the patients with ischaemic stroke, 79% were provided a care plan at discharge, compared with 78% of those with ICH, 57% of those with TIA, and 62% of those with an undetermined stroke type.

FIGURE 20: CARE PLAN PROVIDED IF DISCHARGED HOME OR TO RESIDENTIAL AGED CARE, BY HOSPITAL

ACHIEVABLE BENCHMARK*†: 98% **AVERAGE ADHERENCE†: 72%**



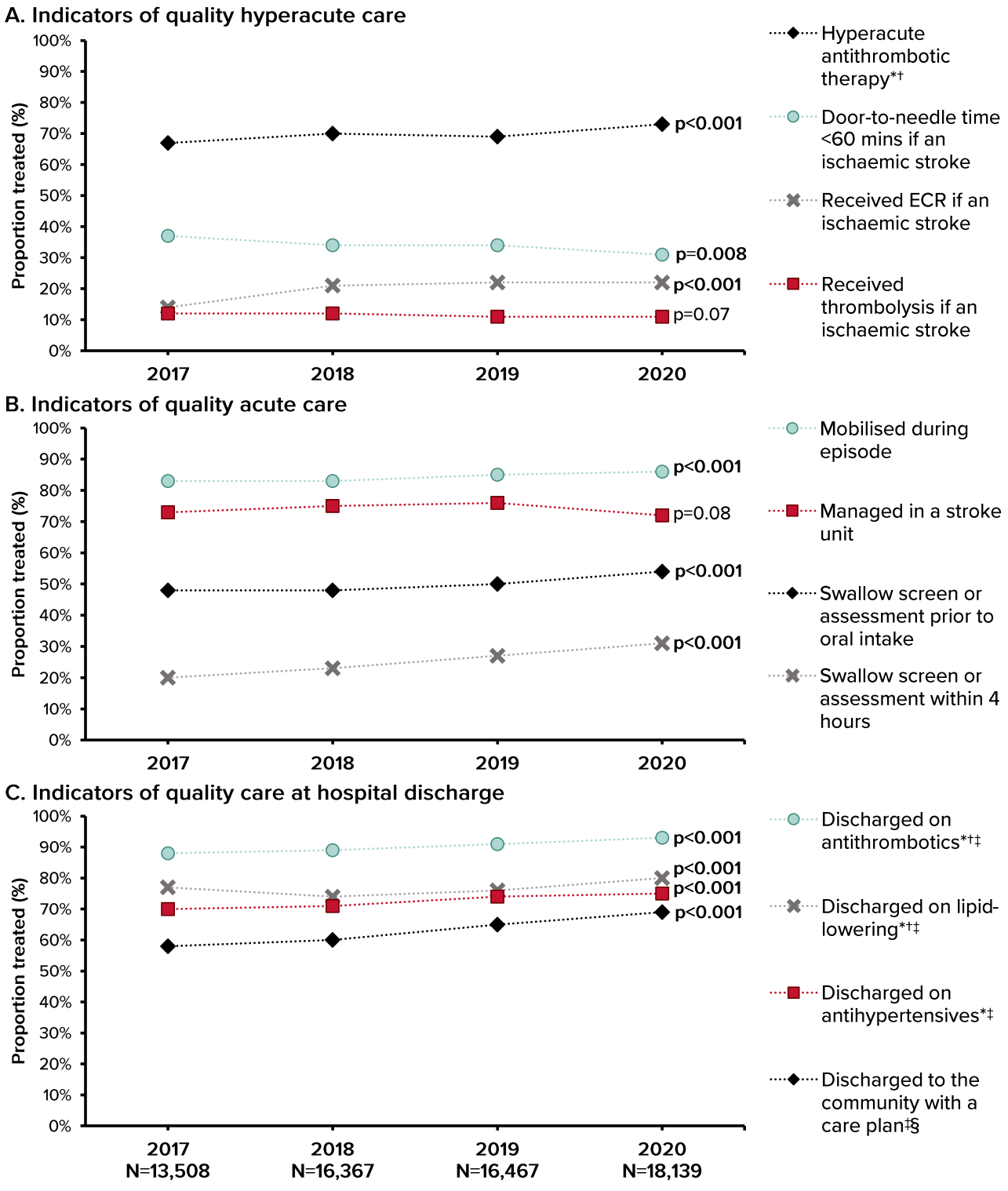
Each dot represents the mean adherence for an individual hospital.
** Benchmarks based on a modified ABC™ method using data from sites with at least 50 eligible episodes.*
† Adherence and benchmarks relate only to admitted episodes discharged directly home or to residential aged care.

CHANGES IN QUALITY OF ACUTE CARE OVER TIME

In 2020, there were 47 hospitals which had participated in the AuSCR since 2017 and had provided data on ≥30 episodes of stroke or TIA in each year. This provided an important opportunity to assess the influence of participation in the AuSCR for these hospitals over time for selected indicators of quality stroke care. Among these 47 hospitals, the number of episodes of stroke or TIA increased from 13,508 in 2017 to 18,139 in 2020. Of these episodes, half were aged ≥75 years, 45% were female, and 40% were able to walk on admission (no significant differences by year). Since 2017, an increase in the assignment of ischaemic stroke diagnoses was observed while the use of undetermined diagnoses declined.

As depicted in Figure 21, adherence to all major indicators of quality stroke care improved between 2017 and 2020 apart from: access to thrombolysis, door-to-needle time within 60 minutes, and stroke unit care. Access to thrombolysis has remained at 11% for the previous four years, while the proportion treated within 60 minutes has steadily declined. In 2020, access to stroke unit care markedly reduced compared to earlier years and represents a likely consequence of the COVID-19 pandemic. A more detailed evaluation of the impacts of the COVID-19 pandemic on stroke care in the AuSCR is reported on page 27.

FIGURE 21: CHANGES IN ADHERENCE TO SELECTED QUALITY INDICATORS SINCE 2017



Data represent the national average adherence to selected quality indicators for a sub-set of 47 hospitals which consistently participated in the AuSCR between 2017 and 2020 and contributed ≥30 episodes each calendar year.
P values derived using a linear test for trend.
ECR: endovascular clot retrieval (applicable for hospitals participating in the AuSCR Black and Violet programs only).
* Excludes contraindicated episodes.
† Excludes episodes of intracerebral haemorrhage.
‡ Excludes episodes resulting in death while in hospital and emergency department episodes.
§ Includes only episodes discharged directly home or to residential aged care.

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 >1 hospital 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 19,818 adult patients with stroke/TIA, 1,708 patients (9%) died while in hospital. Patient mortality was similar between men and women after adjustment for age, stroke type and severity (p=0.41). Case fatality was greater for episodes of ICH (27%) when compared to ischaemic (7%), undetermined (8%) and TIA (<1%; p<0.001). There were three paediatric in-hospital deaths reported.

LENGTH OF STAY

Of the 19,441 admitted episodes that were known to be alive at the time of hospital discharge, 19,073 had valid information provided on length of stay. Of these episodes, 796 (4%) stayed 21 days or more. The median length of stay was four days (Q1 to Q3: 2 to 7 days; Table 8). Patients with TIA more often had a short length of stay (less than five days) compared to patients with stroke (90% TIA, 52% 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 7 days) and those not treated in stroke units (median 2 days, Q1 to Q3: 1 to 6 days, p<0.001).

Table 8: Median length of stay

	Median length of stay in days (Q1, Q3)
All episodes	4 (2, 7)
Ischaemic	4 (2, 7)
Intracerebral haemorrhage	6 (3, 11)
Transient ischaemic attack	1 (1, 2)
Undetermined	3 (1, 5)
Treated in a stroke unit	4 (2, 7)
Not treated in a stroke unit	2 (1, 6)

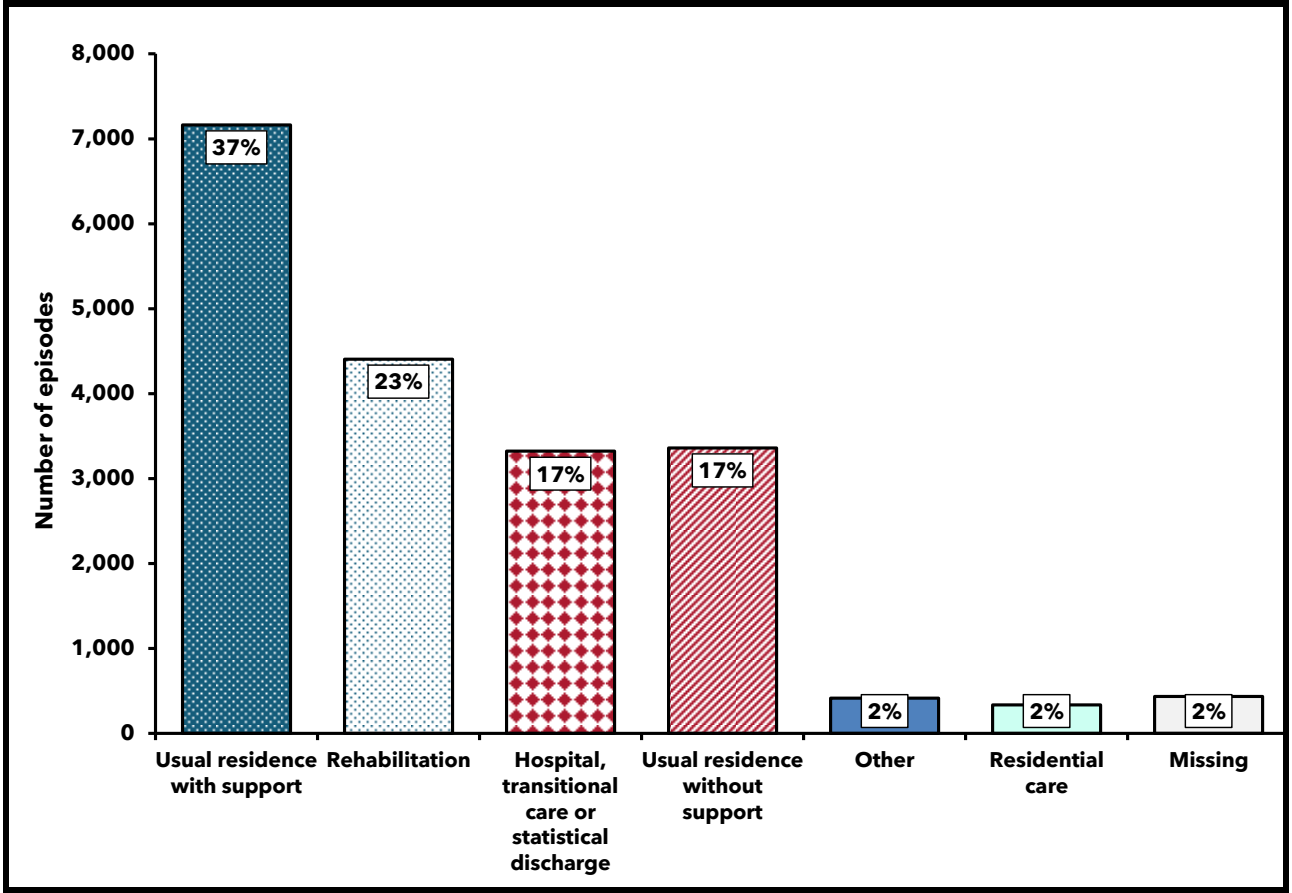
DISCHARGE DESTINATION

In 2020, excluding in-hospital deaths, approximately half of the admitted episodes of care resulted in patients being discharged to their usual residence (n=10,525; 54%), with the majority of these patients requiring support (Figure 22). 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 were 80% more likely to be discharged to a rehabilitation facility compared to those patients not managed in a stroke unit (odds ratio 1.80, 95% confidence interval 1.62–1.99, $p<0.001$) when adjusted for age, sex, type of stroke, ability to walk on admission, inpatient or community-onset stroke, and whether 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 (35% vs 22% unable to walk on admission, $p<0.001$; 16% vs 6% able to walk on admission, $p<0.001$).

Most patients with TIA (89%, n=3,150) 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 27 patients with TIA who were discharged to residential aged care, 30% had a documented history of a previous stroke.

FIGURE 22: DISCHARGE DESTINATION



N=19,441 episodes.
Excludes episodes of care resulting in death while in hospital.

IMPACTS OF THE COVID-19 PANDEMIC ON CARE

The consecutive collection of patient care data has permitted unique insights from across the country on the effects of the COVID-19 pandemic on acute stroke care. Globally there were concerns about delays in people with stroke symptoms presenting to hospital with the steepest declines in stroke presentations occurring immediately following stay at home orders.[15] Emerging evidence from other countries suggested that there were mixed results on the impact on arrival times or delivery of stroke treatments.[16]

We formed a COVID-19 AuSCR Reporting Consortium Group (Appendix K) to analyse and interpret the AuSCR data from 64 hospitals that had data available in 2019 and 2020. The 2019 data were used as the historical control period.

The early impacts of the COVID-19 pandemic on acute stroke care in Australia have been reported previously.[17] The COVID-19 AuSCR Reporting Consortium Group was formed to investigate any changes to acute stroke care as a result of measures taken in hospitals to ensure the virus does not spread and that health care workers and visitors are kept safe.

This was investigated in two ways. Firstly, voluntary feedback about changes to acute stroke care from hospital clinicians was obtained by survey. Secondly, AuSCR participant data were analysed in time series.

CLINICIAN FEEDBACK SURVEY

A set of 23 closed or open-ended questions were developed and distributed electronically to hospital clinicians by email and newsletter. The first survey was distributed in May with 61 responses from 54 hospitals (75% of hospitals; 20 hospitals from Victoria) and the second survey at the end of August: 66 responses from 58 hospitals (81% of hospitals; 25 Victoria hospitals). A summary of the perceived impacts to stroke care for Victoria, where the greatest number of restrictions and COVID-19 cases occurred in 2020, and other locations is provided in Table 9. Of concern was the reduced capacity to provide stroke unit care including the redeployment of stroke services staff to other duties. Clinicians also described the impact of patients having fewer visitors during the pandemic resulting in reduced opportunities for support and information provision to relatives, by the stroke team. Internal communications about redeployment of services or patient flow changes were also problematic at some hospitals. Delays to time-critical stroke treatment were identified and attributed to COVID screening and altered triage processes. Adverse impacts on nursing staff ratios, and the interdisciplinary skill base were also reported.

Table 9. Perceived changes to stroke services due to the COVID-19 pandemic

	May		October	
	Victoria	Other states	Victoria	Other states
Stroke unit location	33%	23%	19%	12%
Stroke unit size/capacity	13%	9%	0%	6%
Re-deployment of stroke staff to other duties	33%	26%	33%	34%
Length of stay	20%	14%	24%	13%
Discharge destination	7%	14%	21%	10%

PARTICIPANT DATA

The AuSCR participant data were analysed using interrupted time series analysis to assess trends in the provision of evidence-based treatments recommended in the national standards for acute stroke. For the interrupted time series analysis, there was adjustment for seasonality, and the number of episodes per week by stroke type (ischaemic stroke, intracerebral haemorrhage, TIA and undetermined stroke).

In Australia, the first case of COVID-19 was recorded in late January 2020 and national restrictions to control the virus commenced in March, with the peak of the first wave on the 27th of March (460 cases). Following a period of over a month from early April with fewer than 30 cases a day, a second wave of cases began in June within Victoria, peaking on the 29th of July (721 cases). From October, there were relatively few cases for the remainder of 2020. Three interruption periods were chosen: (1) the week of the first COVID-19 death in Australia (1/Mar/2020); (2) the end of the first wave (9/Jul/2020); and (3) the week that the stay-at-home order was lifted after the second wave (20/Oct/2020).[18]

In this analysis, we present the differences in access to treatment in a stroke unit between states, and the differences between stroke units and alternate ward settings in the provision of other evidence-based therapies within Victoria.

Data from 40,813 episodes from 64 hospitals contributing to the AuSCR in 2019 and 2020 were included in the analysis, with 19,332 episodes in 2019 and 21,481 episodes in 2020. There were no differences in age and sex between years (26% aged <65 years, 56% male).

In 2020 compared to 2019, fewer patients were provided with management in a stroke unit (77% vs 73%, p<0.001). Victoria was impacted more than in other states in providing access to stroke unit care (Figure 23), with an average decline of 0.24% per week in Victoria between the 1/Mar/2020 and 20/Oct/2020. The proportion of patients provided thrombolysis declined by 0.08% per week in Victoria during the pandemic period (Figure 24). There was no trend in the proportion provided thrombolysis within 60 minutes of arrival to hospital in Victoria (Figure 25).

FIGURE 23: TREATMENT IN A STROKE UNIT EACH WEEK, BY STATE

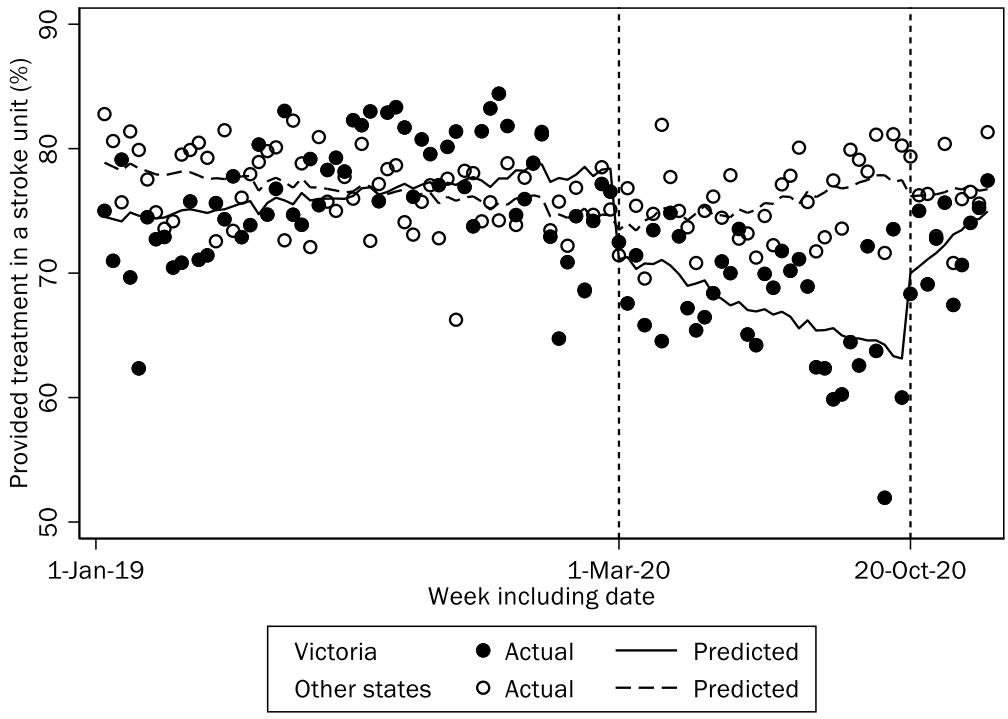


FIGURE 24: PROVISION OF THROMBOLYSIS EACH WEEK, BY STATE

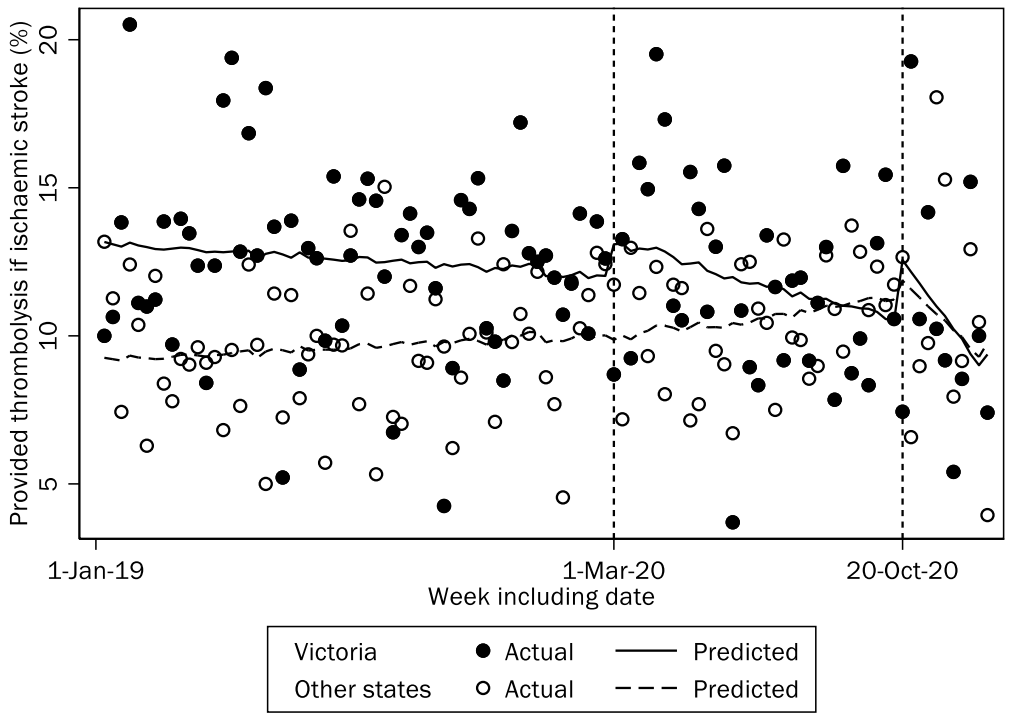
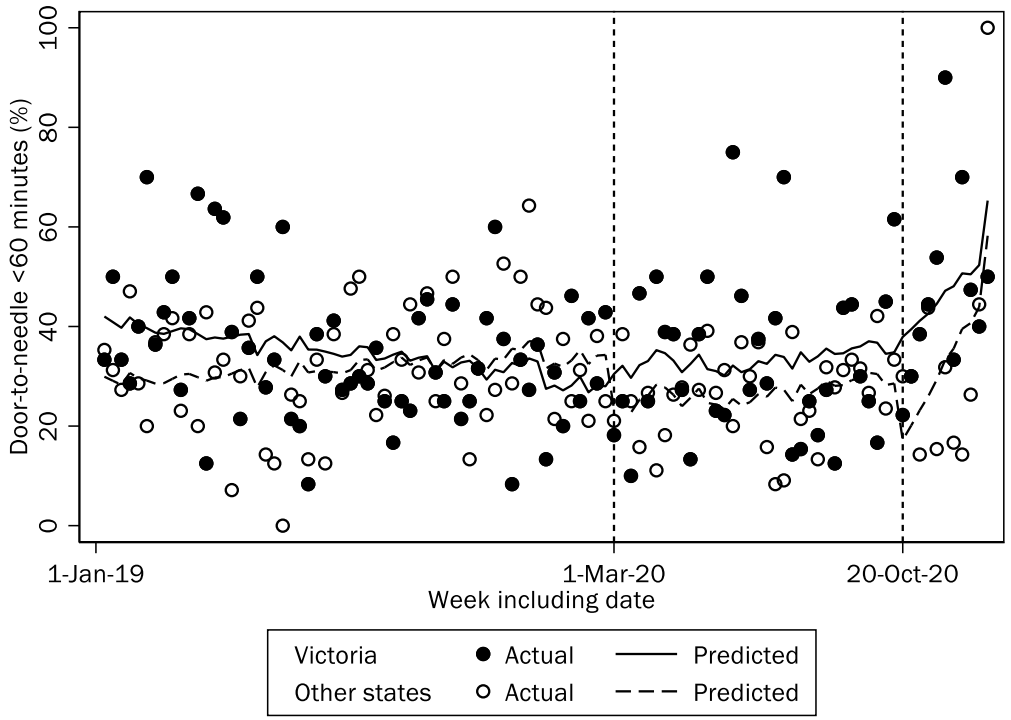


FIGURE 25: DOOR-TO-NEEDLE TIME <60 MINUTES EACH WEEK, BY STATE



Stroke unit care remained superior to the alternate wards in the provision of evidence-based processes of care that are recorded in the AuSCR during the pandemic. Changes to the provision of care after admission during the pandemic period included:

- ***Provision of antithrombotic medication within 48 hours*** (Figure 26)- improved by 0.05% per week in stroke units.
- ***Mobilisation within a day of admission*** (Figure 27) - after an initial increase in mobilisation in alternate wards on the week of the interruption, there was a reduction of 0.2% per week.
- ***Swallow screen or assessment*** (Figure 28) - improved by 0.19% per week in alternate wards.
- ***Discharge to rehabilitation*** (Figure 29) - an initial increase in the proportion going to rehabilitation from alternate wards with no subsequent change.
- ***Combination of secondary prevention medications at discharge*** (Figure 30) – initially improved in both groups on the week of the interruption (5% for stroke unit and 10.5% for alternate wards), and subsequent small increases over time (0.07% per week for stroke unit and 0.12% per week for alternate wards).
- ***Discharged to the community with a care plan*** (Figure 31) - decreased by 0.04% per week in stroke units and increased by 0.3% per week in alternate wards.

FIGURE 26: HYPERACUTE ANTITHROMBOTIC THERAPY EACH WEEK, BY STATE

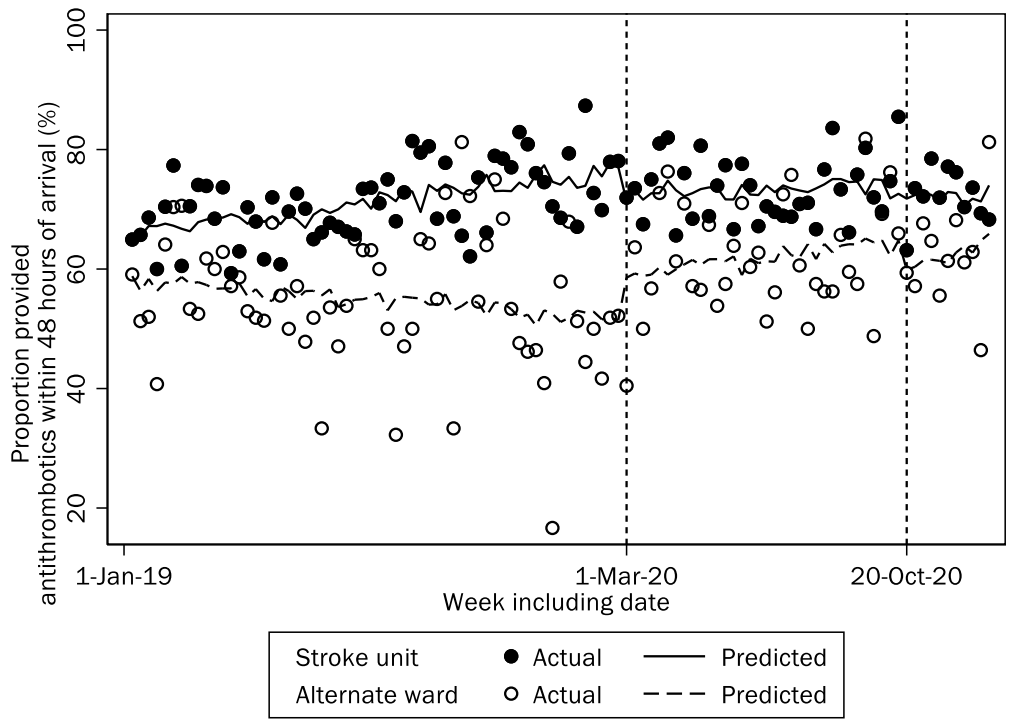


FIGURE 27: MOBILISATION SAME DAY OR DAY AFTER ARRIVAL EACH WEEK, BY TREATMENT IN A STROKE UNIT

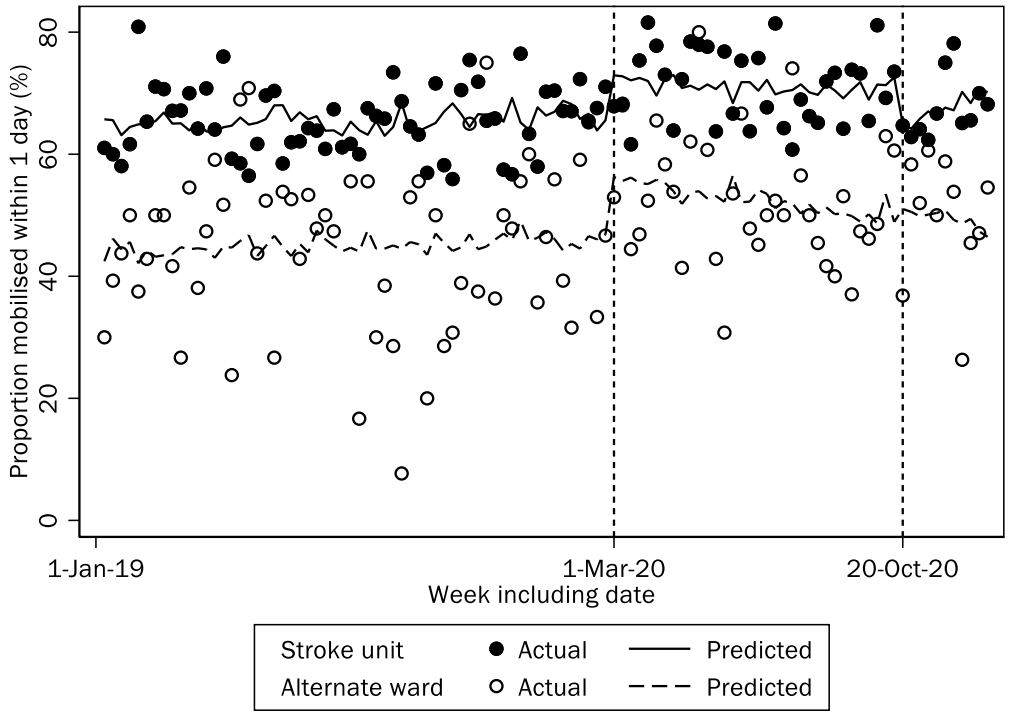


FIGURE 28: SWALLOW SCREEN OR ASSESSMENT EACH WEEK, BY TREATMENT IN A STROKE UNIT

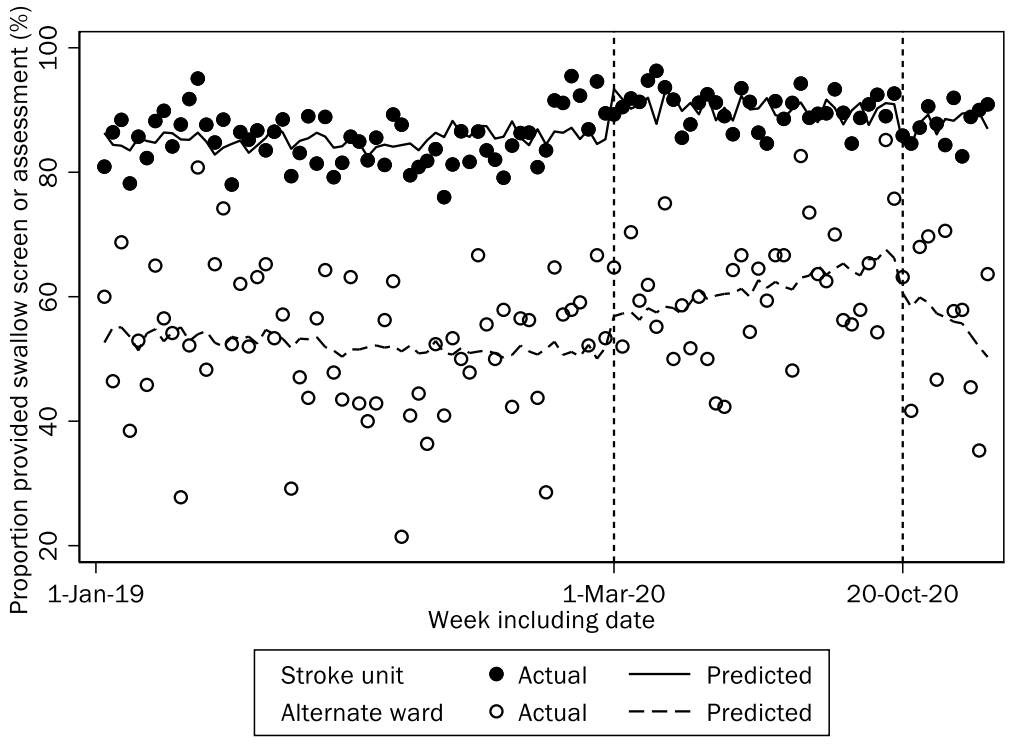


FIGURE 29: DISCHARGED TO REHABILITATION EACH WEEK, BY TREATMENT IN A STROKE UNIT

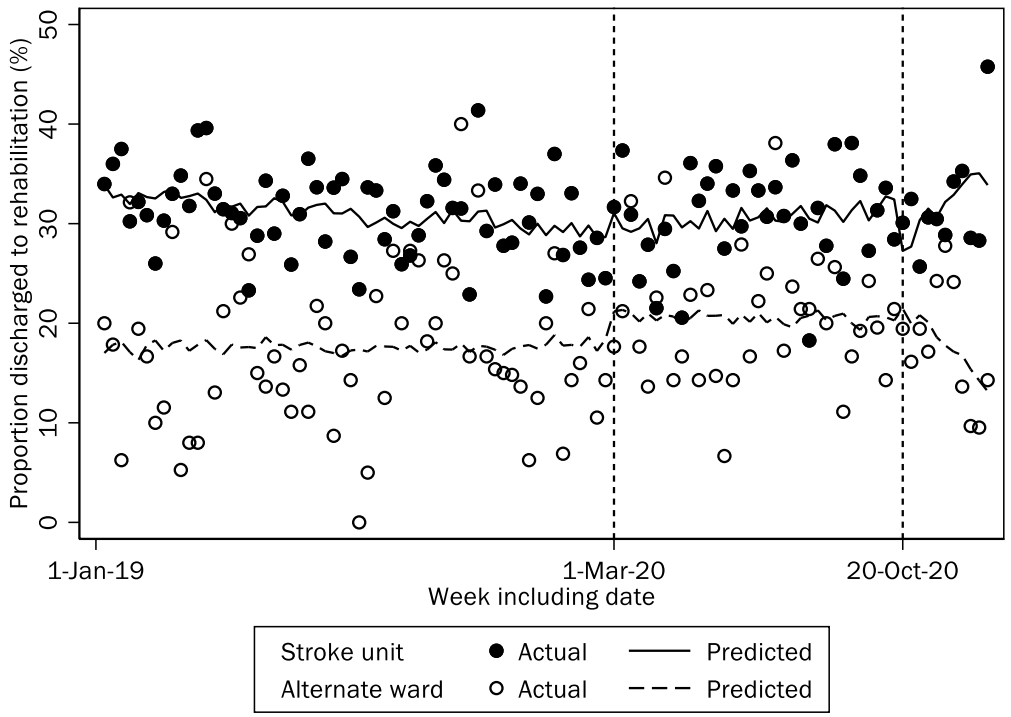
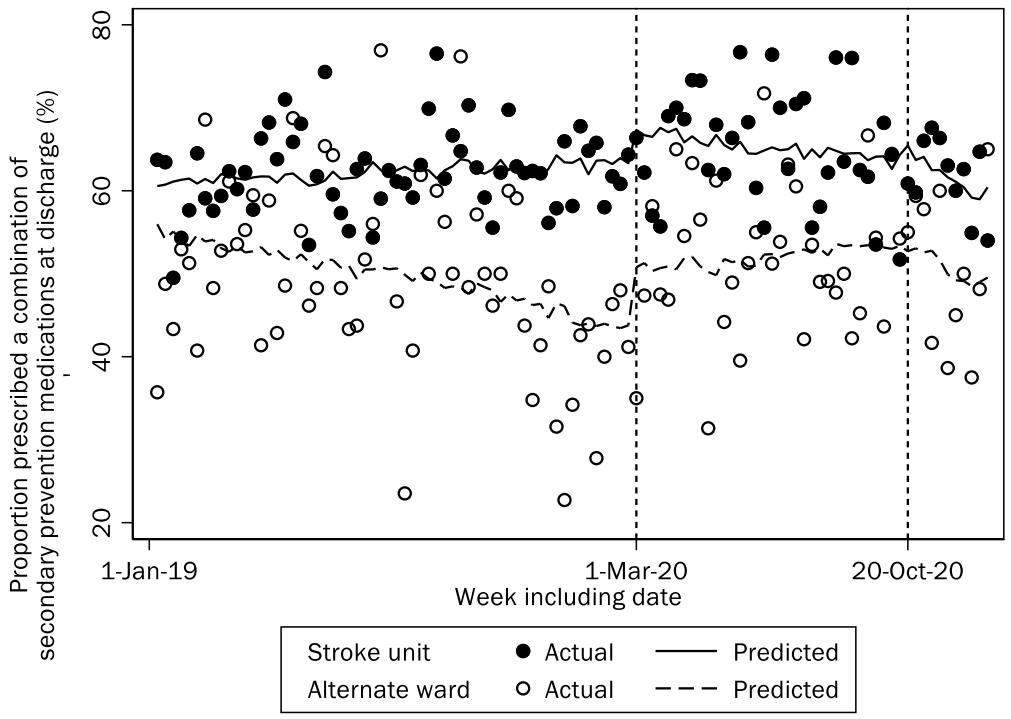
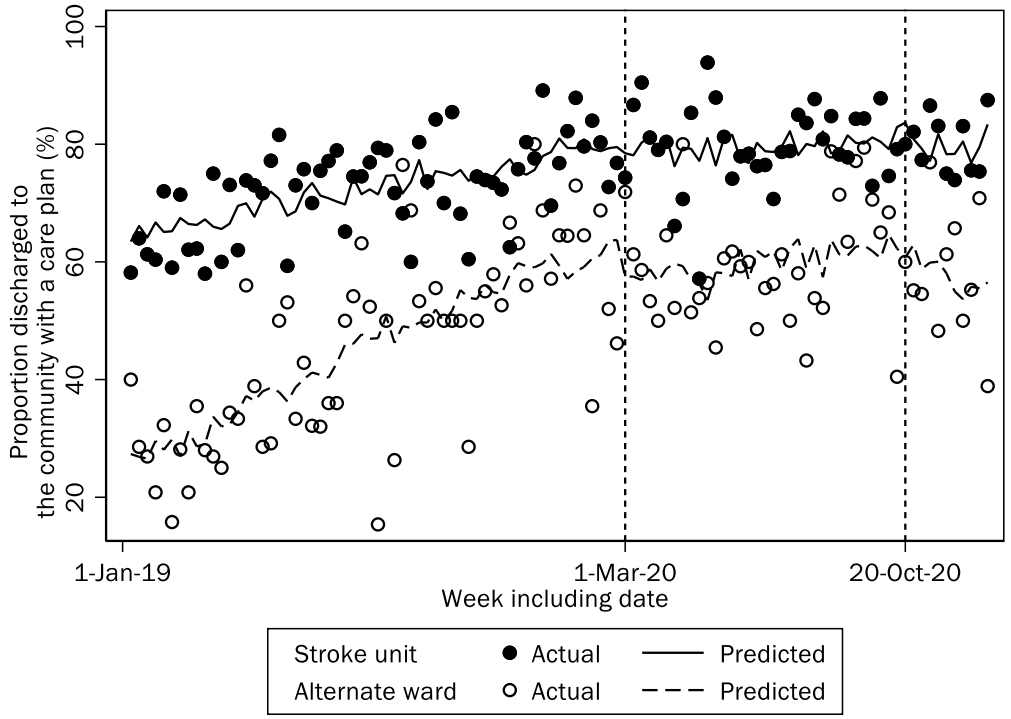


FIGURE 30: DISCHARGED ON A COMBINATION OF MEDICATIONS EACH WEEK, BY TREATMENT IN A STROKE UNIT



*Combination of medications defined as an antihypertensive, antithrombotic, and lipid-lowering medication for patients with ischaemic stroke (excluding those with documented contraindications).

FIGURE 31: DISCHARGED TO THE COMMUNITY WITH A CARE PLAN EACH WEEK, BY TREATMENT IN A STROKE UNIT



These findings illustrate the importance of collecting continuous and standardised data to inform policy and practice in stroke care under rapidly changing circumstances. In 2020, the COVID-19 pandemic had affected the quality of acute stroke care, in particular for Victoria where the greatest case numbers and restrictions were imposed.

Hospital workflows and processes, while needing to be flexible during a pandemic, should not mean that patients with stroke are disadvantaged and in particular, access to specialised stroke units should be maintained to provide patients with the best opportunities for recovery.

POST-DISCHARGE HEALTH INFORMATION

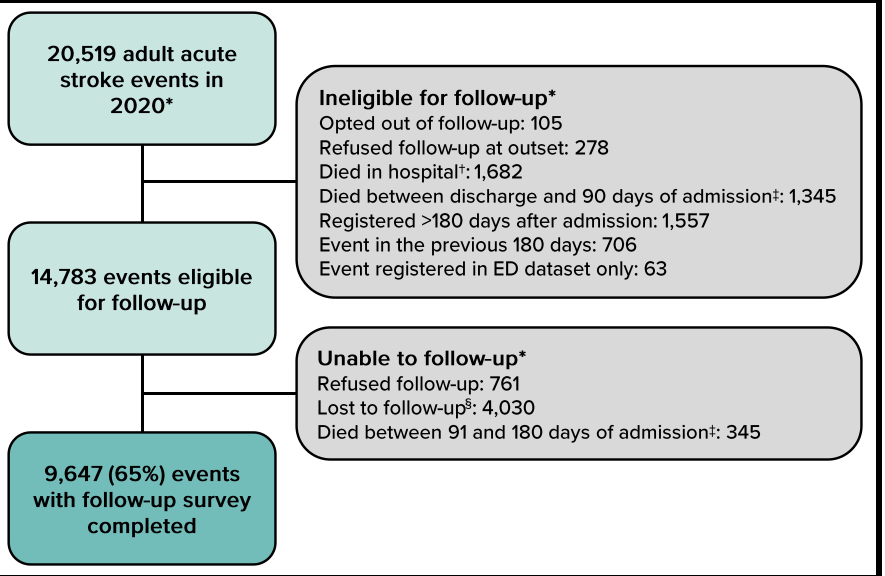
RESPONSE RATES

In 2020, there were 14,783 unique stroke or TIA events eligible to complete a follow-up survey among 14,715 adult patients whereby there were 68 recurrent events in patients which were also eligible for another follow-up survey in the same calendar year. In 2020, 9,647 (65%) of these eligible events for registrants living with stroke or TIA, or their proxies, provided information about their health status (Figure 32). Responders tended to be slightly older in age, admitted for a less severe stroke, and were more often managed in a stroke unit (Table 10).

There were also 43 episodes occurring in patients under the age of 18. Four of these patients died prior to follow-up at 90-180 days following admission and 15 of these patients, or their proxies, completed follow-up.

The median time to completion of follow-up for adult responders was 143 days following admission (Q1 to Q3: 107 to 175 days).

FIGURE 32: FOLLOW-UP OF PATIENT EVENTS IN 2020 (EXCLUDING PAEDIATRIC EPISODES)



** Reasons for ineligibility are not mutually exclusive (i.e. a patient may be ineligible for follow-up for more than one reason).*
† In-hospital deaths were reported by AuSCR hospitals and validated using linked data from the National Death Index.
‡ Post-discharge death information was determined through linkage of data with the National Death Index.
§ Contact unable to be made using our follow-up protocol (2 postal attempts and 1 telephone attempt).

PARTICIPATION IN RESEARCH

Among the 9218 adult patients who answered the question about whether they would be willing to be contacted to participate in future research, 5746 (62%) replied affirmatively. Compared to those who did not reply in the affirmative, these patients were younger (median age 73 vs 77 years, $p<0.001$) and more often male (61% vs 53%, $p<0.001$).

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. In 2020, 47% (n=4,289) of the 9185 adult patients who answered this question indicated that they would like to receive such information from the Stroke Foundation.

Table 10: Characteristics of adult patients with and without post discharge information

	Completed (n=9,601)	Not completed (n=5,114)	*p* value
Age (years), mean (SD)	73 (13)	70 (15)	<0.001
Age (years), median (Q1 to Q3)	74 (65 to 82)	72 (60 to 82)	<0.001
Female, n (%)	4,022 (42)	2,155 (43)	0.31
Aboriginal and/or Torres Strait Islander, n (%)	143 (2)	145 (3)	<0.001
Clinical diagnosis, n (%) *Ischaemic* *Intracerebral haemorrhage* *Transient ischaemic attack* *Undetermined*	 6737 (71) 791 (8) 1930 (20) 88 (1)	 3,548 (70) 467 (9) 952 (19) 78 (2)	<0.001
Able to walk on admission, n (%)	4708 (52)	2189 (46)	<0.001
Length of hospital admission (days), median (Q1 to Q3)	4 (2 to 7)	4 (2 to 8)	<0.001
Treated in a stroke unit, n (%)	7289 (77)	3775 (74)	0.005

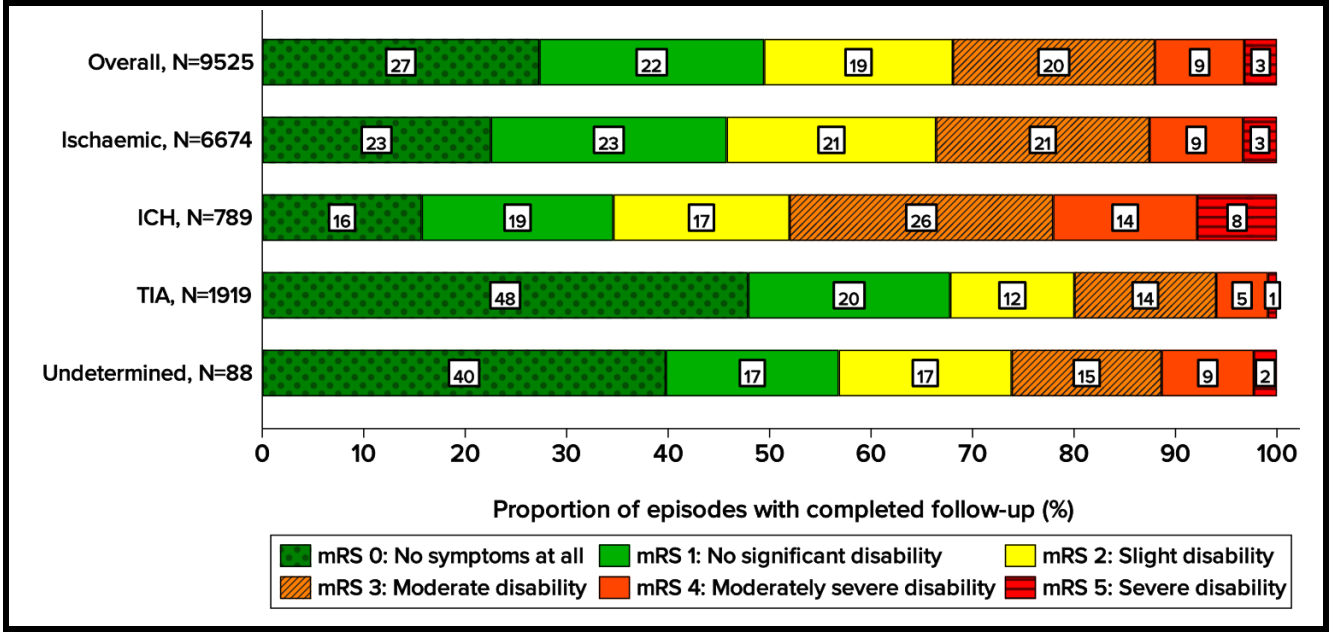
SD: standard deviation; Q1: 25th percentile; Q3: 75th percentile.

DISABILITY – MODIFIED RANKIN SCALE

The modified Rankin Scale (mRS) is used widely in stroke studies to describe person-centred global disability outcomes in terms of the degree of disability, or dependence, in daily activities with reference to pre-stroke activities. Of those providing responses to the mRS at follow-up, 27% were free from disability (mRS= 0) and 22% had no significant disability despite symptoms (mRS=1; Figure 33).

The unadjusted median mRS score reported by patients with ICH or ischaemic stroke was two (i.e. moderate disability), compared to a median mRS score of one (i.e. no significant disability despite symptoms) for patients with undetermined stroke or TIA. Patients who were residing at home at the time of follow-up had lower levels of disability compared to those not residing at home (median mRS 1 vs 4; p<0.001).

FIGURE 33: UNADJUSTED MODIFIED RANKIN SCALE SCORE BY CLINICAL DIAGNOSIS AT FOLLOW-UP



mRS: modified Rankin Scale; ICH, intracerebral haemorrhage; TIA, transient ischemic attack.

READMISSIONS AND LIVING ARRANGEMENTS

At follow-up, approximately one in five adult patients reported hospital readmissions (Table 11). Most patients who were followed up were living at home (88%), 24% of whom were living alone. There were 808 (8%) patients living in low-level care or high-level care for whom information at follow-up was obtained.

HEALTH-RELATED QUALITY OF LIFE

With respect to health-related quality of life, problems were most frequently reported with completion of usual activities (Figure 34). Approximately three in four (74%) responders reported problems with ≥1 dimension of the EQ-5D-3L.

FIGURE 34: UNADJUSTED PROPORTION OF PATIENTS REPORTING PROBLEMS WITH EQ-5D-3L DIMENSIONS

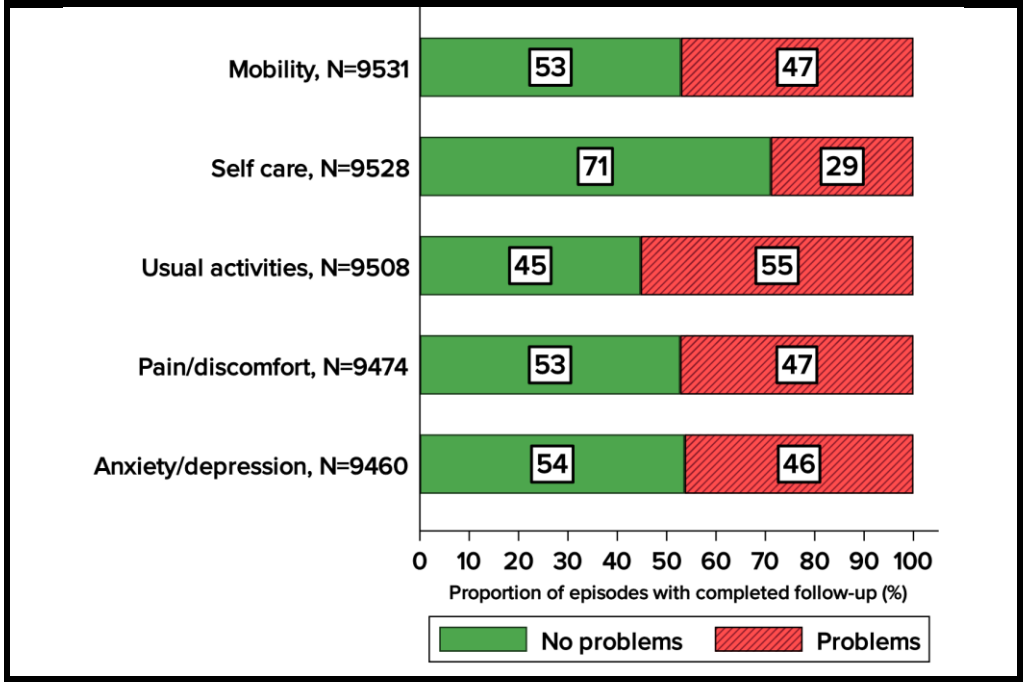


Table 11: Recurrent strokes, readmissions and living arrangements

	N=9,544
	n (%)
Had a recurrent stroke	405 (4)
Readmitted to hospital	2,101 (22)
Time to readmission (days), median (Q1, Q3)	77 (35, 115.5)
Reason for readmission	**N=2,081**
Stroke or transient ischaemic attack	346 (17)
Cardiovascular disease	311 (15)
Elective surgery	239 (11)
Injury	195 (9)
Other neurological condition	169 (8)
Infection	123 (6)
Respiratory disease	76 (4)
Gastrointestinal disease	94 (5)
Other	528 (25)
Location at time of follow-up interview	**N=9,565**
Home	8,460 (88)
Living alone *Living with others*	2,052 (24) 6,357 (76)
With care support *Without care support*	4,053 (48) 4,407 (52)
Institutional care or other setting	1,105 (12)
In hospital *Transitional care services* *Low level care (hostel care)* *High level care (nursing home)* *Inpatient rehabilitation*	87 (8) 85 (8) 49 (4) 759 (69) 62 (6)

Missing responses excluded from denominators.

HEALTH-RELATED QUALITY OF LIFE (continued)

Patients with ICH reported problems in all dimensions of the EQ-5D-3L more commonly than the other diagnoses (Table 12). The mean Visual Analogue Scale (VAS) score, which represents patients' self-reported overall health, was 69 (median: 75; min-max: 0-100). Compared to the mean VAS of the normative population (83 in the United Kingdom),[11] the VAS scores of AuSCR patients were >8 points worse, representing a clinically meaningful difference.[19]

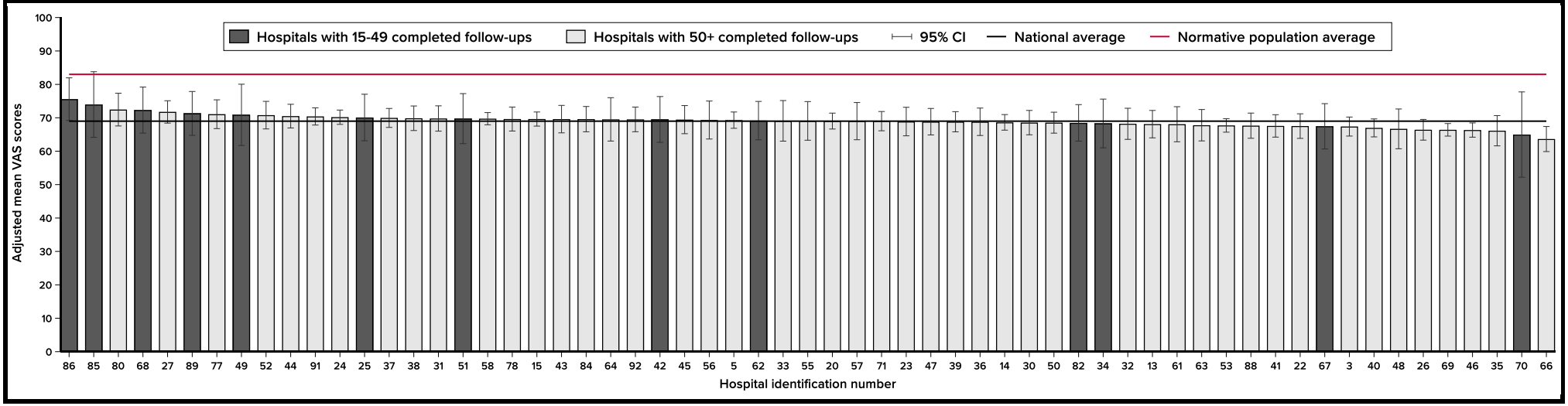
The overall minimum and maximum mean VAS scores differed between AuSCR hospitals by 12 points after adjustment for patient demographics and stroke clinical characteristics (Figure 35). Compared to patients who were discharged directly home or to aged care, those who were discharged to in-patient rehabilitation were 17% more likely to report a VAS score above the national median, after adjusting for patient demographics and stroke clinical characteristics.

Table 12: Unadjusted health-related quality of life, by diagnosis

EQ-5D-3L dimension	Ischaemic N=6,766	ICH N=794	TIA N=1,943	Undetermined N=89
Mobility	48%	56%	39%	43%
Self-care	30%	42%	19%	24%
Usual activities	58%	69%	41%	52%
Pain/Discomfort	48%	51%	43%	41%
Anxiety/Depression	47%	54%	41%	40%
VAS mean (SD)	68 (22)	64 (24)	73 (20)	69 (22)
VAS median (Q1-Q3)	73 (51-85)	70 (50-81)	79 (60-90)	73 (50-88)

ICH: intracerebral haemorrhage; TIA: transient ischaemic attack; VAS: visual analogue scale. Missing responses (<2%) excluded from denominators.

FIGURE 35: HEALTH-RELATED QUALITY OF LIFE SCORES ACCORDING TO THE ADJUSTED VAS AT FOLLOW-UP, BY HOSPITAL

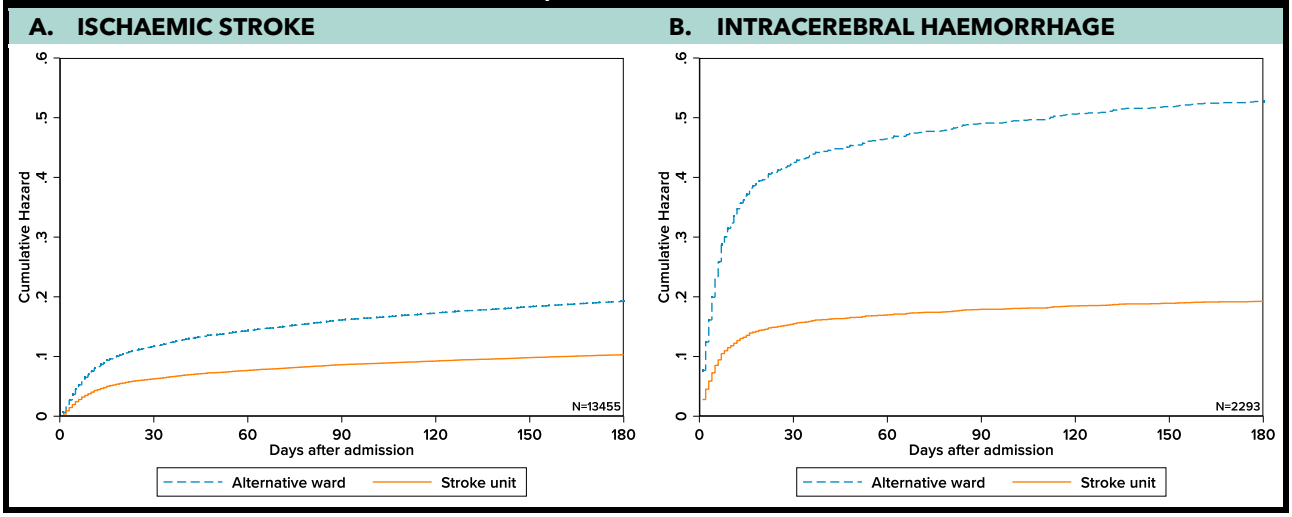


Hospitals with fewer than 15 episodes with completed follow-up were excluded. Mean of 83 for the normative population of adults was obtained from the United Kingdom.[11]

SURVIVAL

Survival status was ascertained for the entire AuSCR cohort using data linkage with the National Death Index. Of the total patients with stroke or TIA registered in 2020, 9% died prior to hospital discharge, 6% between discharge and 90 days of admission, and 2% between 91 and 180 days of admission. In patients with ischaemic stroke, treatment in a stroke unit was associated with a 46% lower hazard of death at 180 days after admission than treatment on an alternate ward (hazard ratio 0.54, 95% confidence interval 0.49-0.59, $p<0.001$; Figure 36). A larger effect of a 64% lower hazard of death was found for patients with ICH (hazard ratio 0.36, 95% confidence interval 0.32-0.42, $p<0.001$). These analyses were adjusted for age, sex, ability to walk on admission, in-hospital stroke and transfer from another hospital.

FIGURE 36: CUMULATIVE HAZARD OF DEATH, BY TREATMENT IN A STROKE UNIT



RISK ADJUSTED MORTALITY

Risk adjusted mortality rate (RAMR) comparisons at 30 days following admission for ischaemic stroke and ICH have been plotted for tertiary referral hospitals that offer ECR services (yellow dots) and for other hospitals that do not offer ECR services (black dots; Figure 37 and Figure 38).

To ensure reliable estimates, analyses were conducted for individual hospitals that provided at least 200 episodes of ischaemic stroke and at least 50 episodes of ICH in 2020. For hospitals with fewer episodes, data from 2019 and 2020 were pooled and used to derive mortality estimates if the minimum number of episodes was achieved across both years (i.e. 200+ for ischaemic and 50+ for ICH). RAMRs for tertiary referral hospitals have been colour coded separately as these hospitals are more likely to treat a different cohort of stroke patients, including more complex and severe cases, than other hospitals participating in the AuSCR.

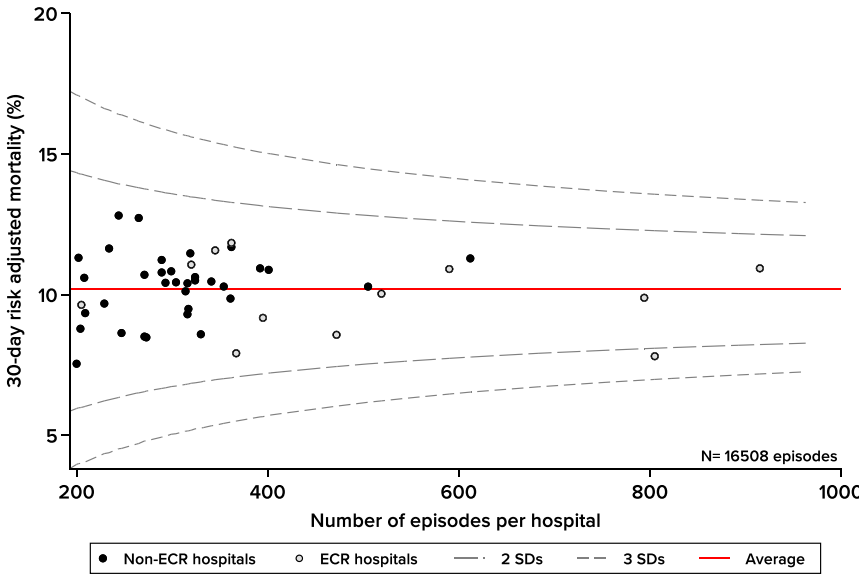
All RAMR models were adjusted for age, sex, socioeconomic position, stroke type, previous history of stroke, and a measure of stroke severity:

For ischaemic stroke, we adjusted for stroke severity using the National Institutes of Health Stroke Scale (NIHSS). Because NIHSS scores were missing for approximately one in three episodes, multiple imputation techniques were used to assign an NIHSS score from another episode that had a similar set of patient characteristics (e.g. matched on age, sex, hospital ID, ability to walk on admission, transfer from another hospital, in-hospital stroke, and previous history of stroke).

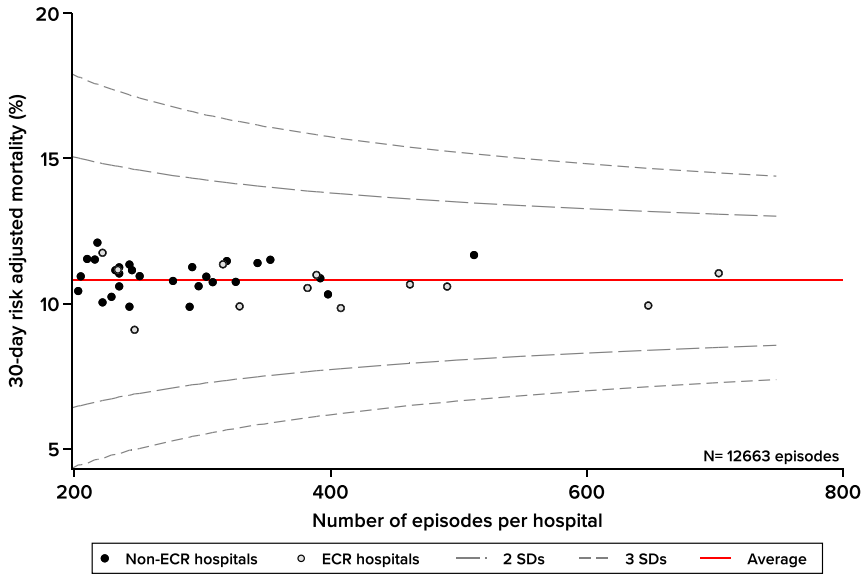
For ICH, it was not possible to adjust RAMR models using NIHSS scores as they were missing for the majority (>50%) of episodes and could not be reliably imputed. Therefore, similar to earlier years, RAMR models for ICH were adjusted for stroke severity using the ability to walk on admission (a validated measure of post-stroke outcome).[13]

FIGURE 37: 30-DAY RISK ADJUSTED MORTALITY FOR ISCHAEMIC STROKE

A. INCLUDING TRANSFERS



B. EXCLUDING TRANSFERS



NOTES:

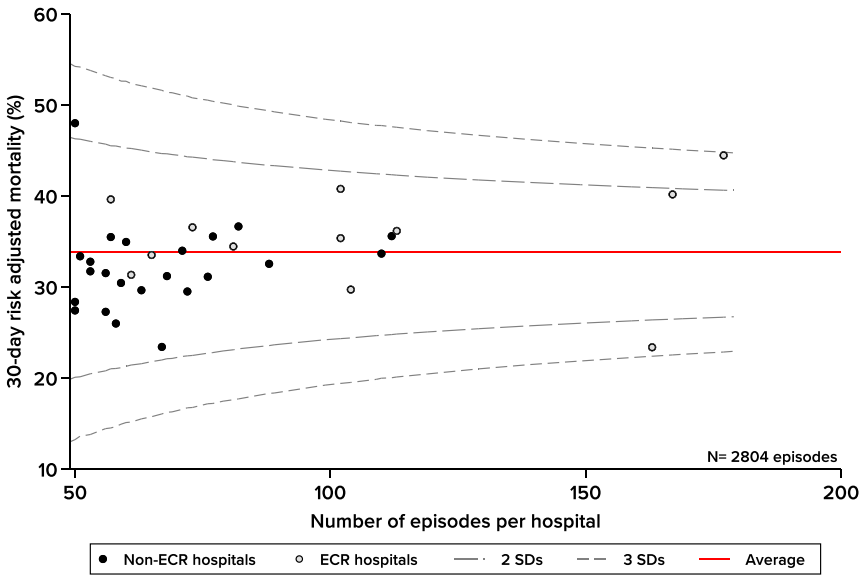
Each dot represents the risk-adjusted percentage of patients who were deceased within 30 days of admission at each hospital

Excludes in-hospital strokes and hospitals with less than 200 episodes for ischaemic stroke.

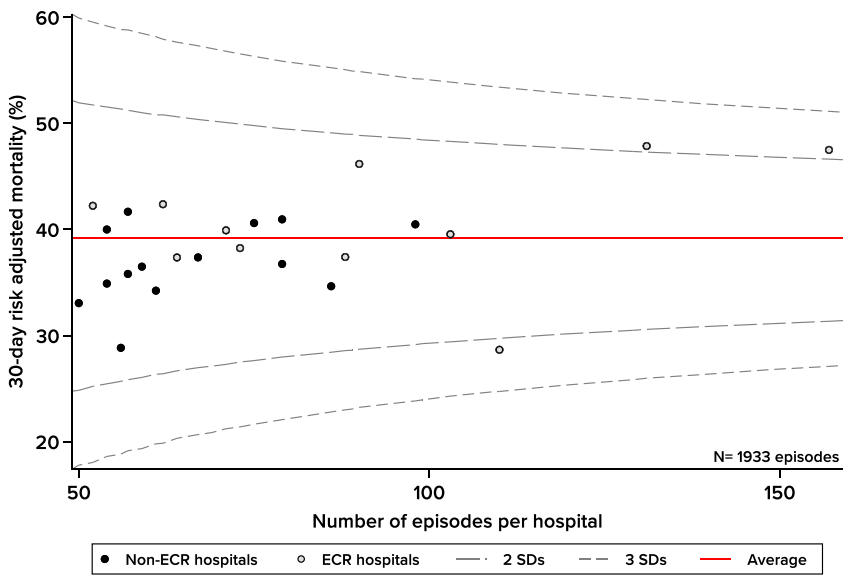
ECR: endovascular clot retrieval

FIGURE 38: 30-DAY RISK ADJUSTED MORTALITY FOR INTRACEREBRAL HAEMORRHAGE

A. INCLUDING TRANSFERS



B. EXCLUDING TRANSFERS



NOTES:

Each dot represents the risk-adjusted percentage of patients who were deceased within 30 days of admission at each hospital

Excludes in-hospital strokes and hospitals with less 50 episodes for intracerebral haemorrhage.

ECR: endovascular clot retrieval

DISCUSSION

In the 2020 AuSCR Annual Report, we present information on 21,512 episodes of stroke and TIA collected at 68 hospitals across seven states and territories. This is the largest annual number of episodes to be added to the AuSCR, representing a 7% increase from 2019, whereby 72 hospitals had contributed data.

Overall, 2020 was a successful year for the AuSCR despite impacts created by the COVID-19 pandemic and state government funding for hospitals in NSW ceasing at the end of June. We were pleased that eight additional hospitals had elected to use the optional ED data collection program, which became available in 2019 (28 hospitals in total now using this program). An overview of care provided to patients in the optional ED program is provided in Appendix L. The number of hospitals electing to contribute data to the optional FeSS program increased to 22, from 17 in 2019.

We also had three meetings of our new AuSCR Clinical Quality Improvement (QI) Committee which is chaired by Professor Geoff Cloud (Alfred Health, VIC). The overarching aim of the committee is to prioritise and support QI initiatives across participating AuSCR hospitals. The Committee will also have a role in providing support for state-based clinical networks in their review and use of the AuSCR data for QI and in lobbying governments to support better hospital care.

Another advancement of the AuSCR was the launch of a specific and expanded Paediatric dataset on 31 July 2020. The newly developed AuSCR paediatric dataset forms an integral part of the Paediatric Acute Code Stroke (PACS) study, a national study funded by the Medical Research Future Fund, with additional support from the Stroke Foundation. In 2021, the paediatric subcommittee will be formally established under the leadership of Mark Mackay and Belinda Stojanovski.

Given the ongoing COVID-19 pandemic situation, and restrictions in Melbourne for the majority of 2020, staff from the AuSCR Office adapted operations to continue work remotely.

The registry was managed as close as possible to pre-pandemic operations, however some changes in processes were necessary, including:

- Postponement of all hospital visits and onsite medical record audits.
- Significant postal delays for follow-up data collection. This was also a factor in the increased numbers of attempts to collect patient reported outcomes by phone.
- We continued to train and support hospitals via videoconference including hosting several educational webinars and provided updates to hospitals and collaborators via our AuSCR newsletters.

In 2020, we also held our 8th National Stroke Quality Improvement workshop in partnership with the Stroke Foundation and Monash University. This was conducted as a virtual event, permitting many more people to attend (>300). Four sessions were held over three days, including:

- *Health Care Improvement Initiatives*, 21 Oct
- *Prehospital, Emergency and Hospital Care*, 28 Oct
- *National Stroke Data Linkage Group*, 29 Oct
- *Telerehabilitation*: 29 Oct

National and international awards. For the second time our hospitals had their data analysed for the Australian Stroke Coalition (ASC) awards of Excellence in Quality of Stroke Care, which assess adherence to the National Acute Care Stroke Standards, and for the World Stroke Organization (WSO) Angels Awards. Each hospital was provided with a tailored report with their results to inform them of areas they could focus on to make them eligible for an award in the next year. Congratulations to all recipients and we hope that these awards will inspire further quality improvement activities (Appendix E).

Data quality

The AuSCR office continues to work with hospitals in relation to improving documentation of the NIHSS, and other variables. The quality of data continues to improve with fewer cases of undetermined stroke type or missing type of stroke than previous years. The proportion of missing or unknown NIHSS scores have also decreased by 18% since 2018. Better capture of NIHSS scores in the AuSCR has provided an opportunity to improve our statistical methods for adjusting outcome models.

The overall median rate of case ascertainment by hospital improved by 7% from last year (77% in 2019 to 84% in 2020). The AuSCR office will continue to work with hospitals to highlight the importance of case ascertainment and reducing the potential for selection biases. In 2020, the AuSCR was also able to receive ICD-10 discharge diagnosis data for participating Victorian hospital sites as a single data file from the Victorian Agency for Health Information (VAHI). This streamlined process reduced the burden on clinicians and health information departments to provide case ascertainment data at each hospital. We will continue to work with VAHI and other state governments to reduce the workload for each hospital with this aspect of data quality.

Acute care for stroke

Access to stroke units, the cornerstone of ensuring access to best practice stroke care, was provided to 73% of patients, with impacts from COVID-19 emerging as a reason for reduced access in 2020. Of continued concern, on average only three hospitals achieved a median door-to-needle time for thrombolysis within 60 minutes. Furthermore, only one in two patients received dysphagia screening or assessment prior to oral intake. This care process is vital for patient safety following stroke,[20] and has been shown to be amenable to intervention in the ED.[20,21] Several hospitals were found to be outside the limits set for normal variation in relation to the clinical care performance measures. Processes of care with the most variation were management in a stroke unit, swallow screen or assessment within four hours of hospital arrival, and provision of a discharge care plan.

AuSCR State Coordinators will continue to work with hospitals to understanding the variable definitions and the summary data provided in their tailored data reports. For 2020, these tailored reports have been enhanced following feedback from various clinicians and the Chair of the CQI committee. In 2020 we also provided stroke performance results for Victorian Hospital Board reports on the request of Victorian Agency for Health Information and summarised data reports for hospital CEOs in Queensland and Victoria.

In this annual report we present an overview of the changes in quality of care since 2017 across the national acute care standard indicators for stroke. Reassuringly, we found evidence of steady improvements in access to most hyperacute and acute treatments since 2017 (hyperacute antithrombotic therapy, proportion receiving ECR, being mobilised, receiving a swallow screen/assessment within 4 hours or prior to food or drink). However, there was a decline in the proportion of patients receiving thrombolysis within 60 minutes, and overall access to this treatment has not changed. The ability to reliably track changes over time in care quality is a strength of the registry. Audit and feedback programs are the cornerstone of a Clinical Quality Registry, such as the AuSCR, and can expect to change clinical practice by around 5%.[22] Where use of the data can be more actively fed back to hospitals, in programs like StrokeLink, greater shifts in adherence to process of care can be achieved.[23] We encourage increased resourcing of these QI activities to empower staff from hospitals to act on their AuSCR data.

In this report we highlighted the impacts of the COVID-19 pandemic which may explain some of the results related to acute care quality. Hospital workflows and processes, while needing to be flexible during a pandemic, should not mean that patients with stroke are disadvantaged. Access to specialised stroke units should not be compromised during a pandemic. Access to time critical treatments should not diminish. Maintaining access to stroke units is paramount to ensuring best practice care even during a pandemic.

Follow-up data

The overall rate of follow-up completion for eligible patients was 65% and, despite the workflow disruptions of COVID-19, is a testament to AuSCR Office team. This is an excellent outcome by international standards of stroke registries. For example, in recent data from the Sentinel Stroke National Audit Programme, 30% of eligible patients were followed up.[24] Maintenance of the overall proportion of follow-up response rate 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 2021 we plan to build and commence testing an electronic version of the follow-up survey which will be distributed via short message service (SMS) for those who have provided a mobile phone number and are randomly selected to complete the survey using this new method.

In 2020, we provided the final report to the Victorian Agency for Health Information for a project which was to seek feedback on, and codesign, the preferred formats for reporting 'site-level' patient-reported outcome measures (PROMs) data to clinicians.[25] In this report, we have applied the findings in the graphical representation of our data, where relevant. The publications relating to this work are being finalised so this form of clinical quality 'registry science' can be available to a wider audience.[26]

Case mix adjusted analyses of the EQ-5D-3L VAS showed a 12-point difference between best and worst hospital-based results and exceeds the reported clinically meaningful difference of 8-10 points.[9] Further analysis is needed to explore the contributing factors to these variations HRQoL between hospitals. QI programs, such as the StrokeLink program, may play an important role in investigating these differences through facilitated workshops provided conducted at local hospitals.

The number of people registered in the AuSCR living with stroke will to be contacted for invitations for research studies grew by almost 6,000 in 2020. Every year survival status is updated in the registry and the AuSCR currently has 30,395 people living with stroke who are willing to be contacted for research studies. This provides an important national source of research infrastructure for stroke. Up to the end of 2020, there had been 21 research studies where AuSCR office had sent an invitation to eligible AuSCR registrants to participate in a study on behalf of investigators for approved projects.

Conclusion

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 and the need to ensure that the quality of care is not diminished during a pandemic.

REFERENCES

1. Australian Commission on Safety and Quality in Health Care. Framework for Australian clinical quality registries. 2014. www.safetyandquality.gov.au/our-work/health-and-medical-research/national-arrangements-clinical-quality-registries. Accessed Oct 7, 2021.
2. Australian Department of Health. National Clinical Quality Registry and Virtual Registry Strategy. 2020; www.health.gov.au/internet/main/publishing.nsf/Content/national_clinical_quality_registry_and_virtual_registry_strategy_2020-2030. Accessed Nov 11, 2021.
3. Cadilhac DA, Lannin NA, Anderson CS, et al. Protocol and pilot data for establishing the Australian Stroke Clinical Registry. *Int J Stroke.* 2010;5(3):217-226.
4. Evans SM, Loff B, Cameron PA. Clinical registries: the urgent need to address ethical hurdles. *Med J Aust.* 2013;198(3):134-135.
5. Australian Stroke Coalition. National Stroke Data Dictionary; Mar 2021. www.strokefoundation.org.au/Australian-Stroke-Coalition/AusDAT. Accessed Nov 3, 2021.
6. Australian Bureau of Statistucs. Australian Statistical Geography Standard (ASGS): Volume 5 - Remoteness Structure. 2016; www.abs.gov.au/websitedbs/d3310114.nsf/home/remoteness+structure. Accessed Oct 27, 2021.
7. Kiefe CI, Weissman NW, Allison JJ, Farmer R, Weaver M, Williams OD. Identifying achievable benchmarks of care: concepts and methodology. *Int J Qual Health Care.* 1998;10(5):443-447.
8. Hall RE, Khan F, Bayley MT, et al. Benchmarks for acute stroke care delivery. *Int J Qual Health Care.* 2013;25(6):710-718.
9. van Swieten JC, Koudstaal PJ, Visser MC, Schouten HJ, van Gijn J. Interobserver agreement for the assessment of handicap in stroke patients. *Stroke.* 1988;19(5):604-607.
10. EuroQol--a new facility for the measurement of health-related quality of life. *Health Policy.* 1990;16(3):199-208.
11. Kind P, Dolan P, Gudex C, Williams A. Variations in population health status: results from a United Kingdom national questionnaire survey. *Bmj.* 1998;316(7133):736-741.
12. Cadilhac DA, Kilkenny MF, Levi CR, et al. Risk-adjusted hospital mortality rates for stroke: evidence from the Australian Stroke Clinical Registry (AuSCR). *Med J Aust.* 2017;206(8):345-350.
13. Counsell C, Dennis M, McDowall M, Warlow C. Predicting outcome after acute and subacute stroke: development and validation of new prognostic models. *Stroke.* 2002;33(4):1041-1047.
14. Stroke Foundation. Clinical guidelines for stroke management. 2021; www.informme.org.au/Guidelines/. Accessed Oct 10, 2021.
15. Markus HS, Brainin M. COVID-19 and stroke-A global World Stroke Organization perspective. *Int J Stroke.* 2020;15(4):361-364.
16. Cadilhac DA, Prvu Bettger J. Health Policy and Health Services Delivery in the Era of COVID-19. *Stroke.* 2021;52(6):2177-2179.
17. Cadilhac DA, Kim J, Tod EK, et al. COVID-19 Pandemic Impact on Care for Stroke in Australia: Emerging Evidence From the Australian Stroke Clinical Registry. *Front Neurol.* 2021;12:621495.
18. Parliament of Australia. COVID-19: a chronology of state and territory government announcements. 2020; www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/pubs/rp/rp2021/Chronologies/COVID-19StateTerritoryGovernmentAnnouncements. Accessed Nov 10, 2021.
19. Kim SK, Kim SH, Jo MW, Lee SI. Estimation of minimally important differences in the EQ-5D and SF-6D indices and their utility in stroke. *Health Qual Life Outcomes.* 2015;13:32.
20. Middleton S, McElduff P, Ward J, et al. Implementation of evidence-based treatment protocols to manage fever, hyperglycaemia, and swallowing dysfunction in acute stroke (QASC): a cluster randomised controlled trial. *Lancet.* 2011;378(9804):1699-1706.
21. Middleton S, Coughlan K, Mnatzaganian G, et al. Mortality Reduction for Fever, Hyperglycemia, and Swallowing Nurse-Initiated Stroke Intervention: QASC Trial (Quality in Acute Stroke Care) Follow-Up. *Stroke.* 2017;48(5):1331-1336.
22. Ivers N, Jamtvedt G, Flottorp S, et al. Audit and feedback: effects on professional practice and healthcare outcomes. *Cochrane Database Syst Rev.* 2012(6):Cd000259.
23. Cadilhac DA, Grimley R, Kilkenny MF, et al. Multicenter, Prospective, Controlled, Before-and-After, Quality Improvement Study (Stroke123) of Acute Stroke Care. *Stroke.* 2019;50(6):1525-1530.
24. Intercollegiate Stroke Working Party Publication. Sentinel Stroke National Audit Programme 7th Annual Report. In: London, United Kingdom: School of Population Health and Environmental Sciences, King's College London; 2021: www.hqip.org.uk/resource/sentinel-stroke-national-audit-programme-annual-report-2019-20. Accessed Oct 19, 2021.
25. Ryan O, Breen S, Hancock S, Marion V, Cadilhac DA. *Patient Reported Outcome Measures (PROMs) Pilot Project: Final Project Evaluation Report.* Melbourne: Florey Institute of Neuroscience and Mental Health; Feb 2020.
26. Hancock SL, Ryan OF, Marion V, et al. Feedback of patient-reported outcomes to healthcare professionals for comparing health service performance: a scoping review. *BMJ Open.* 2020;10(11):e038190.

APPENDIX A: GOVERNANCE & 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.

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 2020. 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 Chair for the Management Committee. (See Appendix B for committee membership lists.)

There has been highly valued support from the Victorian Agency for Health Information (VAHI), Queensland Health and the ACT government through joint projects with the Stroke Foundation, Western Australian Department of Health, South Australian government and Tasmania to expand the coverage of the registry.

Collaborations are continuing with staff from the Australian Institute of Health and Welfare to enable the linking of the AuSCR data with government data such as the National Death Index so that survival status can routinely be updated for registrants each year.

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.

We were provided with a donation from Medtronic ($750) and funding support from the CRE Stroke Rehabilitation and Recovery to hold the 8th national stroke quality workshop that was co-convened with the Stroke Foundation and Monash University. We appreciated the in-kind support from various state government representatives and collaborators in planning the event. 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, and to also establish the first National Stroke Quality Awards program.

APPENDIX B: COMMITTEE MEMBERSHIP

AuSCR Steering Committee membership 2020

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]
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	Professor of Neurology, The University of Melbourne [VIC]
Dr Andrew Evans	Geriatrician & Stroke Physician, Westmead Hospital [NSW]
A/Prof 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]
Prof Susan Hillier	Dean, Research (and Research Education), Division of Health Sciences, University of South Australia [SA]
A/Prof Marin Krause	Director Neuroscience Network, Northern Sydney Local Health District, University of Sydney [NSW]
Prof Natasha Lannin	Group Leader, Brain Recovery and Rehabilitation Group, Monash University [VIC]
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]
Ms Jennifer Muller	Chair, Consumer Council, Stroke Foundation [QLD]
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]

AuSCR Management Committee membership 2020

Prof Natasha Lannin (Chair)	**Group Leader, Brain Recovery and Rehabilitation Group, Monash University [VIC]**
Prof Craig Anderson	Executive Director, The George Institute, China & Professor of Neurology and Epidemiology, Faculty of Medicine, UNSW Sydney [NSW]
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 Geoff Cloud	Director of Stroke Services, Alfred Health [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]
Prof Steven Faux	Director, Rehabilitation Unit, St Vincent's Hospital, Sydney [NSW]
A/Prof 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]
Mr Brett Jones	Stroke Liaison Nurse, Canberra Hospital [ACT]
A/Prof Monique Kilkenny	Head, National Stroke Data Linkage Program, Monash University [VIC]
Prof Chris Levi	Director of Clinical Research and Translation - Research Innovation and Partnerships & Co-Director of Acute Stroke Services, John Hunter Hospital [NSW]
Ms Belinda Stojanovski	Stroke Nurse Consultant, Royal Children's Hospital [Vic]

AuSCR Reperfusion and Telemedicine Subcommittee membership 2020

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]**
Prof Christopher Bladin	Director, Victorian Stroke Telemedicine Program, The Florey Institute of Neuroscience and Mental Health & Neurologist Eastern Health [VIC]
Prof Ken Butcher	Director, Clinical Neurosciences, Prince of Wales Hospital [NSW]
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 Andrew Cheung	Managing Director, Sydney Neurointerventional Specialists [NSW]
Prof Alan Coulthard	Interventional Neuroradiologist, Royal Brisbane and Women's Hospital [QLD]
A/Prof Peter Hand	Neurologist, Royal Melbourne Hospital [VIC]
A/Prof Tim Kleinig	Head, Neurology, Royal Adelaide Hospital [SA]
A/Prof Henry Ma	Neurologist, Monash Medical Centre & Adjunct Senior Lecturer, Stroke and Ageing Research Group, Southern Clinical School, Monash University [VIC]
Dr Ferdi Miteff	Neurologist, Royal North Shore Hospital [NSW]
Prof Mark Parsons	Honorary Neurologist, Royal Melbourne Hospital [VIC]
Dr Rebecca Scroop	Interventional Neuroradiologist, Royal Adelaide Hospital [SA]
Dr Brendan Steinfort	Director of Clinical training for Radiology, Royal North Shore Hospital, [NSW]
Dr Jason Wenderoth	Director of Neurointervention, Prince of Wales and Liverpool Hospitals, [NSW]
Dr Andrew Wong	Neurologist, Royal Brisbane and Women's Hospital [QLD]
Prof Bernard Yan	Neurointerventionist and Neurologist, Royal Melbourne Hospital [VIC]

AuSCR Clinical Quality Improvement committee membership 2020

Prof Geoffrey Cloud (Chair)	**Director of Stroke Services, 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]
Dr Andrew Moey	Consultant Neurologist, Lyell McEwin Hospital [SA]
Ms Anne Hooper	Nurse Navigator Stroke, Mackay Base Hospital [Qld]
Ms Belinda Stojanovski	Stroke Nurse Consultant, Royal Children's Hospital [Vic]
Mr Brett Jones	Stroke Nurse Practitioner, Canberra Health Service [ACT]
Ms Aylissa Canning	Princess Alexandra Hospital [Qld]
Ms Kristine Caprecho	Stroke Liaison Nurse, Calvary Public Hospital [ACT]
Ms Katherine Jaques	A/Network Coordinator – Statewide Stroke Clinical Network [Qld]
Ms Janell Cole	North West Regional Hospital [Tas]
Dr Kathryn Colebourne	Stroke Physician, Prince Charles Hospital [Qld]
Ms Linda Edwards	Stroke Clinical Nurse Consultant, Ipswich Hospital [Qld]
Ms Belinda Green	Governance and Data Manager, Alfred Health [Vic]

AuSCR Research Task Group membership 2020

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.

Dr Darshan Ghia (Co-Chair)	**Consultant Neurologist and Head of Stroke Unit, Fiona Stanley Hospital [WA]**
Prof Jacqueline Close (Co-Chair)	**Geriatrician, Prince of Wales Hospital & Clinical Director, NeuRA & Conjoint Professor, University of New South Wales [NSW]**
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, In-patient 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]
Dr Daniel Schweitzer	General Neurologist, Mater Hospital & The Wesley Hospital [QLD]
Dr Karim Mahawish	Consultant in General, Geriatric and Stroke Medicine, MidCentral District Health Board [NZ]
Dr Candice Delcourt	Program Lead, Neurological Program, The George Institute of Global Health & Clinical Associate Professor, Macquarie University & Conjunct Senior Lecturer, The University of New South Wales [NSW]
A/Prof Nadine Andrew	Senior Research Fellow, Peninsula Clinical School, Monash University [VIC]
A/Prof Caleb Ferguson	Adjunct Associate Professor, School of Nursing and Midwifery, Western Sydney University & [NSW]
Dr Elizabeth Lynch	Senior Research Fellow, College of Nursing and Health Sciences, Flinders University [SA]

APPENDIX C: FUNDING 2020

In 2020, the AuSCR Office was supported by funding and in-kind support from the following sources:

- The Florey Institute of Neuroscience and Mental Health
- Commercial partners including Ambulance Victoria and La Trobe University
- Joint initiatives with the Stroke Foundation funded by Queensland Health and ACT Health and contribution to the Australian Stroke Data Tool national coordination roles
- Safer Care Victoria and the Victorian Agency for Health Information
- South Australia, Western Australia and Tasmanian governments
- 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'

INCOME SOURCES	AMOUNT
Governments grants	$ 968,638
The Florey, Stroke Theme support	$ 24,336
Monash University*	$ 14,847
Stroke Foundation**	$ 28,200
Commercial income***	$ 46,226
Hospital opt-in payment	$ 0
Consumer donations	$ 0
TOTAL	$ 1,082,247

**Cost recovery through collaboration on external grants.*
***Australian Stroke Data Tool support and quality improvement activity cost recovery.*
****Income from projects approved by the AuSCR Research Task Group.*

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, Kate Paice, Karen Barclay Moss, Jot Ghuliani, Helen Carter, Adele Gibbs, Violet Marion, Nancy Pompeani, Olivia Ryan, Claire Weickhardt, Shaun Hancock and Lilian Braighi Carvalho
- The researchers from the Stroke and Ageing Research Centre, School of Clinical Sciences, Monash University: Dr Joosup Kim, A/Prof Monique Kilkenny, Lachlan Dalli, Dr Muideen Olaiya, Megan Reyneke, Tharshanah Thayabaranathan
- 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
- Tasmania Health for support of the AuSCR in Tasmania 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 patients with stroke information packages to patients 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

SPECIAL MENTIONS

The Florey AuSCR Office

Dr Sibilah Breen, the AuSCR National Coordinator, was the senior program manager for the coordination of the AuSCR program in 2020.

Sam Shehata and Marcus Lester, the AuSCR and AuSDaT Senior Data Managers, have 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

Lachlan Dalli, Dr Joosup Kim, and A/Prof Monique Kilkenny (Stroke and Ageing Research Centre, Monash University) developed the analytical methods for this report and have contributed to the preparation of various AuSCR reports throughout 2020. We are most appreciative of their contributions. The majority of analyses presented in this report were undertaken by Lachlan Dalli and Dr Joosup Kim, under the supervision of Prof Dominique Cadilhac using de-identified data supplied securely by Marcus Lester. We acknowledge the support from Megan Reyneke in data checking and validation. Methods for the analysis of risk adjusted mortality were initially developed by A/Prof Monique Kilkenny, in consultation with Professor Leonid Churilov (The Florey), and have been adapted with support from Muideen Olaiya.

This report would not have been possible without the efforts of doctors, nurses, ward clerks and other staff from participating hospitals that have contributed data to the AuSCR. Lead clinical and data collection staff for each hospital participating in the AuSCR during 2020 are gratefully acknowledged below.

ACT	
Calvary Health Care	Yash Gawarikar; Kristine Caprecho
Canberra Health Service	Brett Jones; Manju John; Shahla Cowans
NSW	
Blacktown Hospital	Nigel Wolfe; Camelia Burdusel
Lismore Base Hospital	Stephen Moore; Kim Hoffman
Nepean Hospital	Salman Khan; Susan Lane; Martin Zolfel
Port Macquarie Hospital	Kim Parrey; Michelle Coad; Shae Miller; Jennifer Steel
St Vincent's Hospital NSW	Romesh Markus; Kirsty Page; Humyra Hossain
Wagga Wagga Base Hospital	Martin Jude; Katherine Mohr
Westmead Hospital	Andrew Evans; Jacqueline Watson; Phoebe Banatua; Aleksandra Alavanja
Wollongong Hospital	Karen Fuller; Toni Wonson; Jodie Wellfare
QLD	
Bundaberg Base Hospital	Peter Wood; Angelina Crane, Simone Rogers
Caboolture Hospital	Jonnel Boco; Janet Sondergaard; Marnie Hollywood
Cairns Base Hospital	Ramesh Durairaj; Dijana Cukanovic-Krebs; Troy Elliot
Gold Coast University Hospital	Meng Tan; Haylee Berrill
Gympie Hospital	Rohan Grimley; Rebecca Sjodin; Shaji Chacko
Hervey Bay Hospital	Peter Wood; Phyllis Mason; Sarah Leak
Ipswich Hospital	Juan Rois-Gnecco; Linda Edwards; Betzy Shaju
Logan Hospital	Alex Lau; Nicola Hall
Mackay Base Hospital	Neha Nandal; Anne Hooper
Mater Health Services	Daniel Schweitzer; Marie McCaig; Ashley McGuire; Jaimee Rose
Prince Charles Hospital	Alaa Alghamry; Kathryn Colebourne; Caitlin Kearney
Princess Alexandra Hospital	Darshan Shah; Helen Brown; Kate Jaques; Amanda McKee; Aylissa Canning
Queen Elizabeth II Jubilee Hospital	Amanda Siller; Jerry Wong; Kylie Lodge; Paula Jarrett
Queensland Children's Hospital	Adriane Sinclair; Louise Sparks
Redcliffe Hospital	Richard Geraghty; Tanya Williams
Redland Hospital	Joel Iedema; Jenna Allen
Robina Hospital	Meng Tan; Haylee Berrill
Rockhampton Hospital	Leanne Whiley
Royal Brisbane and Women's Hospital	Andrew Wong; Melissa Wood; Lee Moylan
Sunshine Coast University Hospital	Rohan Grimley; Donna Rowley; Jessica Fuller
Toowoomba Hospital	Nisal Gange; Timothy Richardson; Arun Raju; Precious Eleda
Townsville Hospital	Richard White; Sheryl Juliano; Linda Norrie
SA	
Flinders Medical Centre	Matt Willcourt; Michelle Hutchinson
Lyell McEwin Hospital	Andrew Moey; Angela Sayas
Royal Adelaide Hospital	Tim Kleinig; Lizzie Dodd; Carole Hampton

TAS	
Launceston General Hospital	Dinesh Tryambake; Carolyn Harrison
North West Regional Hospital	Nellie Cole
Royal Hobart Hospital	Helen Castley; Deirdre Broadby
VIC	
Albury Wodonga Health - Albury	Vanessa Crosby
Albury Wodonga Health - Wodonga	Vanessa Crosby
Alfred Hospital	Angela Dos Santos; Geoff Cloud; Belinda Green; Kieran Taylor
Austin Hospital	Vincent Thijs; Renae Gamble; Kristen Rowe
Bairnsdale Regional Health Service	Kushantha Gunarathne; Renee Herbstreit; Alison Pearce
Ballarat Health Services	Thomas Kraemer; Ramesh Sahathevan; Casey Hair
Bass Coast Health	Cath Jones; Genette Heslop
Bendigo Health	Mark Savage; Tessa Coupland
Box Hill Hospital	Helen Dewey; Tanya Frost; Karen Stephens
Central Gippsland Health Service	Krishna Mandaleson; Anne van Berkel
Echuca Hospital	Lauren Arthurson
Goulburn Valley Health	Melanie Brown; Katie Connelly
Hamilton Base Hospital	Louise Starkie
Latrobe Regional Hospital	Janet May
Maroondah Hospital	Helen Dewey; Tanya Frost; Karen Stephens
Mildura Base Hospital	Ros Roberts
Monash Medical Centre	Henry Ma; Jodi Lynch; Jessica Miller
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; Bruce Campbell; Lauren Pesavento; Smisha Thomas; Gagan Sharma
St Vincent's Hospital Melbourne	Lauren Sanders; Patrick Scarff
Sunshine Hospital - Western Health	Tissa Wijeratne; Elizabeth Mackey; Jennifer Bergqvist; Tamara Wanklyn
Swan Hill District Health	Trish Oxley; Kath Curran; Emma Harding; Robyn Bailey; Kelly Stanger
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; Mirza Baig; Lorraine Keene; Amanda Lewis
Wimmera Base Hospital	Chris Ebersohn; Deidre Rennick; Leanne Taylor; Nina Roberts
WA	
Fiona Stanley Hospital	Darshan Ghia; Kerri-Ann Whittaker; Gillian Edmonds

APPENDIX E:
ASC AND WSO AWARDS

AUSTRALIAN STROKE COALITION AWARDS

In 2020, there were two Australian Stroke Coalition (ASC) award categories.

Category 1: Provision of nine quality of stroke care metrics

Participating hospitals were judged on nine processes of care collected within the AuSCR in 2019. These processes of care included:

- provision of stroke unit care
- treatment with thrombolysis OR endovascular clot retrieval (if offered by hospital)
- treatment with thrombolysis within 60 mins of hospital arrival
- treatment with endovascular clot retrieval within 90 minutes of hospital arrival
- patients mobilised on the same day or day after hospital arrival
- provision of antihypertensive medication on discharge*
- provision of antithrombotic medications on discharge*#
- provision of lipid-lowering medication on discharge* #
- provision of a discharge care plan if discharged to the community.

* where not contraindicated

excluding haemorrhagic strokes

A composite score based on these nine 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 hospital overall composite score for each hospital was required to be greater than or equal to 70% and have an overall rate of case ascertainment greater than or equal to 70%.

Awards were possible in two categories:

- **EXCELLENCE**: composite score of greater than 80%
- **MERIT**: composite score of greater than 70%

The following hospitals received awards for data collected in the 2019 calendar year

EXCELLENCE AWARDS: Townsville Hospital (QLD); Rockhampton Hospital (QLD); Echuca Regional Health (VIC); Princess Alexandra Hospital (QLD); Wimmera Base Hospital (VIC); Port Macquarie Hospital (NSW); Caboolture Hospital (QLD).

MERIT AWARDS: Box Hill Hospital (VIC); Warrnambool Base Hospital (VIC); Mackay Hospital (QLD); Mildura Base Hospital (VIC); Albury Hospital (VIC); Ipswich Hospital (QLD).

HONOURABLE MENTIONS were given to the following hospitals that had a composite score of greater than 70% BUT who had not submitted data to the AuSCR to enable case ascertainment calculations OR who had a rate of case ascertainment less than 70%: Wagga Wagga Base Hospital (NSW); Blacktown Hospital (NSW); Gold Coast Hospital (QLD); Royal North Shore Hospital (NSW); Prince Charles Hospital (QLD); Bendigo Base Hospital (VIC); Central Gippsland Health Service – Sale (VIC); Canberra Hospital (ACT).

Category 2: Provision of timely reperfusion treatments

MERIT AWARDS required hospitals to have a case ascertainment of ≥70% AND <10% missing data for variables used in calculating these awards and must have also provided data for a minimum of 15 patients in 2019. These were given to hospitals that had a median door-to-needle time for thrombolysis of less than 60 minutes; Box Hill Hospital (VIC), Royal Melbourne Hospital (VIC), and whose median door-to-groin time for ECR is less than 90 minutes; Princess Alexandra Hospital (QLD), Monash Health – Monash Medical Centre (VIC), Royal Melbourne Hospital (VIC), Austin Hospital (VIC).

HONOURABLE MENTIONS were given to hospitals that had either case ascertainment between 60-69% OR more than 10% missing data for one variable used in the calculations. For median door-to-needle time for thrombolysis of less than 60 minutes; Wagga Wagga Base Hospital (NSW), and median door-to-groin time for ECR is less than 90 minutes; Royal North Shore Hospital (NSW).

WORLD STROKE ORGANISATION ANGELS AWARDS

In 2020 for the first time, in partnership with the Australian Stroke Coalition, hospitals that submitted a minimum of 40 consecutive admissions to the AuSCR from 01/07/2019 to 30/06/2020 were eligible for consideration in the WSO Angels Awards. The award categories were Gold status, Platinum status or Diamond status.

Award criteria included the proportion of:

- ischaemic strokes thrombolysed and with a door to needle time < 60 minutes*
- ischaemic strokes undergoing clot retrieval and with a door to groin time < 120 minutes*
- ischaemic strokes thrombolysed and with door to needle time < 45 minutes*
- ischaemic strokes undergoing clot retrieval and with a door to groin time < 90 minutes*
- ischaemic strokes receiving either thrombolysis or clot retrieval*
- all suspected stroke patients undergoing CT or MRI imaging procedure
- all stroke patients undergoing a swallow screen or assessment
- ischaemic stroke patients discharged with antiplatelet medication#
- stroke patients discharged with anticoagulant medication#
- stroke patients treated in a dedicated stroke unit during their hospital stay

* excluding transfers

where not contraindicated

One hospital achieved Gold status: Wagga Wagga Base Hospital (NSW).

APPENDIX F:
PUBLICATIONS AND PRESENTATIONS

Journal Publications

1. Andrew NE, Kilkenny MF, Sundararajan V, Kim J, Faux SG, Thrift AG, Johnston T, Grimley R, Gattellari M, Katzenellenbogen JM, Dewey HM, Lannin NA, Anderson CS, Cadilhac DA. Hospital Presentations in Long-Term Survivors of Stroke: Causes and Associated Factors in a Linked Data Study. *Stroke* 2020; 51: 3673-80. http://doi.org/10.1161/strokeaha.120.030656.
2. Bagot KL, 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. *J Telemed Telecare* 2020; 26: 79-91. http://doi.org/10.1177/1357633x18792380.
3. Bladin CF, Kim J, Bagot KL, Vu M, Moloczij N, Denisenko S, Price C, Pompeani N, Arthurson L, Hair C, Rabl J, O'Shea M, Groot P, Bolitho L, Campbell BC, Dewey HM, Donnan GA, Cadilhac DA. Improving acute stroke care in regional hospitals: clinical evaluation of the Victorian Stroke Telemedicine program. *Med J Aust* 2020; 212: 371-77. http://doi.org/10.5694/mja2.50570.
4. Cadilhac DA, Andrew NE, Busingye D, Cameron J, Thrift AG, Purvis T, Li JC, Kneebone I, Thijs V, Hackett ML, Lannin NA, Kilkenny MF. Pilot randomised clinical trial of an eHealth, self-management support intervention (iVERVE) for stroke: feasibility assessment in survivors 12-24 months post-event. *Pilot Feasibility Stud* 2020; 6: 172. http://doi.org/10.1186/s40814-020-00706-x.
5. Chapman C, Cadilhac DA, Morgan P, Kilkenny MF, Grimley R, Sundararajan V, Purvis T, Johnston T, Lannin NA, Andrew NE. Chest infection within 30 days of acute stroke, associated factors, survival and the benefits of stroke unit care: Analysis using linked data from the Australian Stroke Clinical Registry. *Int J Stroke* 2020; 15: 390-98. http://doi.org/10.1177/1747493019833008.
6. Grimley RS, Rosbergen IC, Gustafsson L, Horton E, Green T, Cadigan G, Kuys S, Andrew NE, Cadilhac DA. Dose and setting of rehabilitation received after stroke in Queensland, Australia: a prospective cohort study. *Clin Rehabil 2020*; 34: 812-23. http://doi.org/10.1177/0269215520916899.
7. Hancock SL, Ryan OF, Marion V, Kramer S, Kelly P, Breen S, Cadilhac DA. Feedback of patient-reported outcomes to healthcare professionals for comparing health service performance: a scoping review. *BMJ Open* 2020; 10: e038190. http://doi.org/10.1136/bmjopen-2020-038190.
8. Kilkenny MF, Dalli LL, Kim J, Sundararajan V, Andrew NE, Dewey HM, Johnston T, Alif SM, Lindley RI, Jude M, Blacker D, Gange N, Grimley R, Katzenellenbogen JM, Thrift AG, Lannin NA, Cadilhac DA. Factors Associated With 90-Day Readmission After Stroke or Transient Ischemic Attack: Linked Data From the Australian Stroke Clinical Registry. *Stroke* 2020; 51: 571-78. http://doi.org/10.1161/strokeaha.119.026133.
9. Lynch EA, Labberton AS, Kim J, Kilkenny MF, Andrew NE, Lannin NA, Grimley R, Faux SG, Cadilhac DA. Out of sight, out of mind: long-term outcomes for people discharged home, to inpatient rehabilitation and to residential aged care after stroke. *Disabil Rehabil* 2020: 1-7. http://doi.org/10.1080/09638288.2020.1852616.
10. Malavera A, Cadilhac DA, Thijs V, Lim JY, Grabsch B, Breen S, Jan S, Anderson CS. Screening for Fabry Disease in Young Strokes in the Australian Stroke Clinical Registry (AuSCR). *Front Neurol* 2020; 11: 596420. http://doi.org/10.3389/fneur.2020.596420.
11. Zhang W, Anderson CS, Kilkenny MF, Kim J, Dewey HM, Andrew NE, Lannin NA, Thrift AG, Grimley R, Sundararajan V, Cadilhac DA. Hospital admissions prior to primary intracerebral haemorrhage and relevant factors associated with survival. *J Stroke Cerebrovasc Dis* 2020; 29: 105026. http://doi.org/10.1016/j.jstrokecerebrovasdis.2020.105026.

Online reports

1. Breen S, Cadilhac DA, Lannin NA, Kim J, Dalli L, Anderson CS, Kilkenny M, 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 2019 Volume 1: Acute Care Provision. The Florey Institute of Neuroscience and Mental Health; December 2020, Report No. 11, 53 pages. www.auscr.com.au/about/annual-reports.

Online reports (continued)

2. Ryan O, Breen S, Hancock S, Marion V, Cadilhac DA. Patient Reported Outcome Measures (PROMs) Pilot Project: Final Project Evaluation Report. In, Melbourne: Florey Institute of Neuroscience and Mental Health, 2020: 1-69. www.health.vic.gov.au/quality-safety-service/reports-for-patient-reported-outcomes-measures.

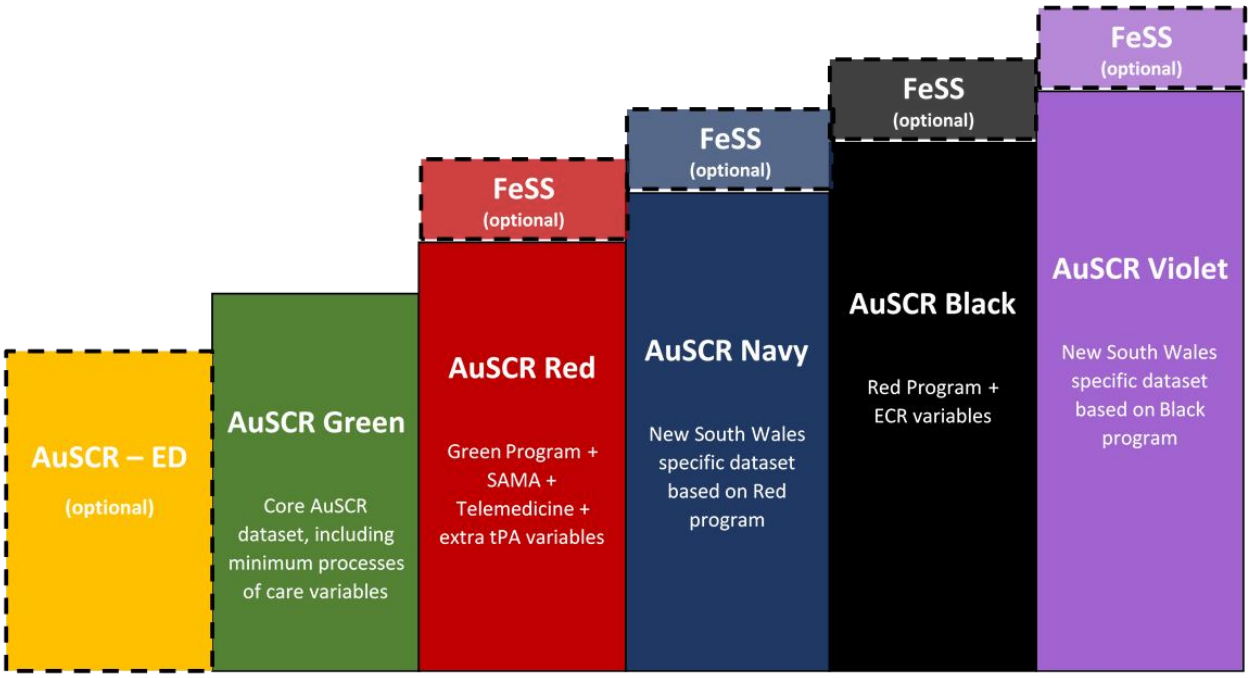
Presentations and posters

1. Breen S, Todd E, Morrison J, Dalli LL, Cadilhac DA. The AuSCR 2019 Annual Report: Australian Stroke Clinical Registry Consortium Webinar. Online. 18 Dec 2020.
2. Kilkenny MF. Big data for stroke: National Stroke Data Linkage Program. Australian Clinical Trials Alliance Summit 2020. Online. 4 Dec 2020.
3. Kilkenny MF, Kim J, Dalli LL, Eliakundu A, Olaiya M. Case Study for Stroke: National Stroke Data Linkage Program. International Population Data Linkage Network Conference. Online. 1-13 Nov 2020. [Symposium]
4. Kilkenny MF. Optimal combination medication treatment improves survival at one year following ischaemic stroke/TIA: Linked Registry and Pharmaceutical claims study. Online. 1-13 Nov 2020.
5. Dalli LL. Association Between Use of Statins and Survival After Stroke: Real-World Data from the Australian Stroke Clinical Registry. International Population Data Linkage Network Conference. Online. 1-13 Nov 2020.
6. Cadilhac DA. Australia. Session Title: Improving Stroke Unit Care Around the World. European Stroke Organisation and World Stroke Organization Conference (ESO-WSO 2020 Virtual). Online. 8 Nov 2020. [Invited talk]
7. Kilkenny MF. Using Big Data to Measure Outcome After Stroke. European Stroke Organisation and World Stroke Organization Conference (ESO-WSO 2020 Virtual). Online. 8 Nov 2020. [Invited talk]
8. Kilkenny MF. Optimal combination medication treatment improves survival at one-year following ischaemic stroke/TIA: Linked Registry and pharmaceutical claims study. European Stroke Organisation and World Stroke Organization Conference (ESO-WSO 2020 Virtual). Online. 8 Nov 2020.
9. Cadilhac DA. Early insights into the unintended consequences of COVID-19 on stroke care. Florey Neuroscience Seminar. Heidelberg, Australia. 30 Oct 2020. [Invited talk]
10. Cadilhac DA. Embedding Routine Linkage with Clinical Quality Registries for Health System Comparative Effectiveness or Economic Evaluations. Inaugural National Stroke Data Linkage Interest Group Virtual Mini Conference. Online. 16 Sep 2020. [Invited talk]
11. Dalli LL. Near-Perfect Medication Adherence is Associated with Improved Survival Post-Stroke. Inaugural National Stroke Data Linkage Interest Group Virtual Conference. Online. 16 Sep 2020.
12. Cadilhac DA. Progress in stroke data and eHealth and how lessons might apply to cardiac rehabilitation. Australian Cardiovascular Health and Rehabilitation Association Annual Scientific Meeting. Online. 11 Aug 2020.
13. Cadilhac DA. The Australian Stroke Clinical Registry: Progress over 10 years and relevance to those with aphasia. Can we do more? Centre of Research Excellence in Aphasia Recovery and Rehabilitation Webinar Seminar Series. Online. 29 Jul 2020. [Invited talk]
14. Ryan OF, Hancock SL. Closing the data feedback loop - Patient Reported Outcome Measures (PROMs): Pilot Project Overview. Heidelberg, Australia. 10 Jul 2020. [Invited talk]
15. Cadilhac DA. Unintended consequences of the COVID response: implications for stroke. Safer Care Victoria, Victorian Government. Online. 1 Jul 2020. [Invited talk]
16. Cadilhac DA. "The importance of continuing to monitor stroke care during the COVID-19 pandemic" on behalf of the AuSCR Consortium, Webinar. Online. 15 May 2020. [Invited talk]
17. Cadilhac DA. Stroke Data in Australia. International Stroke Conference. Los Angeles, California. 19-21 Feb 2020. [Invited talk]
18. Kilkenny MF. International Stroke Conference. Use of big data to improve risk factors, care and outcomes. Los Angeles, California. 19-21 Feb 2020 [Invited talk]
19. Cadilhac DA. Lessons learnt from other quality improvement projects, The STELAR Project, Shared Team Efforts Leading to Adherence Results. IMPROVISE Global Challenges Program Collaborators Meeting. New Delhi, India. 2 Feb 2020. [Invited talk]

APPENDIX G:
AUSCR PROGRAM BUNDLES

In 2020, a total of seven AuSCR data collection programs were available, with the Red and Black programs most commonly used nationally. The Navy and Violet programs were only used in NSW, whilst the Green program was only used at a specialised children's hospital.

The FeSS (Fever, Sugar, Swallow) dataset is an optional add-on to a hospital's usual AuSCR acute data collection program.



Identifying information	Clinical processes	Hospital outcomes data	Timeliness of care delivery	Risk adjustment
• Date of birth • Gender • Contact details (including next of kin) • Hospital name	• Use of tPA • Access to a stroke unit • Discharge antihypertensives • Discharge care plan	• Date of discharge or death • Discharge destination	• Arrival by ambulance • Date/time of stroke onset • Date/time of ED arrival • Date/time of admission • Transfer from other hospital	• ICD-10 codes • Ethnicity • Ability to walk on admission • First ever stroke status • Inpatient stroke • NIHSS on presentation

tPA: thrombolysis **SAMA**: Swallow screen, hyperacute Aspirin, Mobilisation, Antithrombotics **ECR**: Endovascular Clot Retrieval **FeSS**: Fever, Sugar, Swallow

APPENDIX H: AUSCR VARIABLES

AUSCR VARIABLE BUNDLES*

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

EMERGENCY DEPARTMENT DATASET (OPTIONAL DATASET FROM 2019 ONWARDS)
• Date and time of discovery • Pre-hospital notification • Date and time of transfer • Triage category • Advance imaging • Date and time stroke telemedicine consultation conducted • Drug used (e.g. for thrombolysis)
FESS (FEVER, SUGAR, SWALLOW) DATASET (OPTIONAL DATASET FROM 2019 ONWARDS)
• Swallowing – captured with other programs • Assessment and management of fever • Was temperature recorded at least four times on day one of ward admission? • In the first 72 hours following admission did the patient develop a fever ≥ 37.5 0C • Was paracetamol for the first elevated temperature administered within 1 hour? • Assessment and management of hyperglycaemia • Was a finger-prick blood glucose level recorded at least four times on day one of ward admission? • In the first 48 hrs following ward admission did the patient develop a finger-prick glucose level of greater or equal to 10 mmols/L? • Was insulin administered within 1 hour of the first elevated finger-prick glucose (≥ 10 mmol/L)?

*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.

APPENDIX I: APPLICATIONS TO THE AUSCR RESEARCH TASK GROUP

In 2020, there were six external applications reviewed by the Research Task Group:

- Support After Stroke with group-based classeS: The SASS study (PI: PI: Prof Dominique Cadilhac; AIs: Dr Tharshanah Thayabaranathan, Dr Monique Kilkenny, Dr Maarten Immink, Prof Susan Hillier, Prof Amy Brodtmann, Prof Leeanne Carey; Monash University).
- Evaluation of a group-based intervention to enhance adjustment to life with an acquired brain injury: A Phase II randomised controlled trial of VaLiANT (Valued Living After Neurological Trauma) (PI: Dr Dana Wong, AIs: Dr Eric Morris, Dr David Gillanders, Dr Lucy Knox, Prof Roshan das Nair, Mr Nick Sathananthan, Ms Bleydy Dimech-Betancourt, Ms Hannah Miller, Ms Sandy Lotus; Latrobe University).
- Integration of audit and registry data to monitor quality stroke care and outcomes (PI: Dr Monique Kilkenny AI: Prof Dominique Cadilhac, Ms Tara Purvis, Mr Kelvin Hill, Dr Sibilah Breen, Ms Jot Ghuliani, Prof Sandy Middleton; Monash University).
- Understanding the prevention and long-term management of stroke by general practitioners (PI: Dr Joosup Kim, AIs: Dr Monique Kilkenny, Dr Nadine Andrew, Dr Lauren Sanders, Prof Dominique Cadilhac, A/Prof Christopher Pearce, Dr Muideen Olaiya; Monash University).
- Use of lipid-lowering medications among patients with stroke and associated outcomes: using linked national registry and administrative data (PI: A/Prof Monique Kilkenny, AIs: Prof Dominique Cadilhac, A/Prof Nadine Andrew, Dr Joosup Kim, Dr Muideen Olaiya, and Mr Lachlan Dalli; Monash University).
- Development of a digital health platform and care management support program for improving secondary prevention for patients after stroke or transient ischaemic attack. (PI: Dr Jan Cameron, Ais: Prof Dominique Cadilhac, Prof Natasha Lannin, Dr David Silvera, Dr Marlien Varnfield, Dr Jane Li, Dr Christian Redd, Mr Viveka Weiley; Monash University).

APPENDIX J:
PROCESS FOR CALCULATING INDICATORS

Indicator*	Numerator	Denominator	Comments	Applicable program					
				BLACK	NAVY	VIOLET	RED	GREEN	ED
Received stroke unit care	Yes	Yes + No + Unknown + Missing		✓	✓	✓	✓	✓	
Received intravenous thrombolysis	Yes	Yes + No + Unknown + Missing	Includes ischaemic strokes only Excludes episodes provided thrombolysis before arrival to hospital, unless this occurred in a Mobile Stroke Unit	✓	✓	✓	✓	✓	✓
Received brain scan	Yes	Yes + No + Unknown + Missing		✓	✓	✓	✓	✓	✓
Antithrombotic therapy within 48 hours of stroke onset	Yes	Yes + No + Unknown + Missing	Excludes patients with intracerebral haemorrhage, missing stroke type, or if contraindicated	✓	✓	✓	✓		
Received intravenous thrombolysis within 60 minutes of arrival	Yes	Yes + No + Unknown + Missing	Includes ischaemic strokes provided thrombolysis during the current episode only.	✓	✓	✓	✓		✓
Received endovascular clot retrieval	Yes	Yes + No + Unknown + Missing	Includes ischaemic strokes only	✓		✓			
Received groin puncture for endovascular clot retrieval within 90 minutes of arrival	Yes	Yes + No + Unknown + Missing	Includes ischaemic strokes only	✓		✓			
Swallow screen conducted	Yes	Yes + No + Unknown + Missing		✓	✓	✓	✓		✓
Swallow screen or assessment conducted	Yes	Yes + No + Unknown + Missing		✓	✓	✓	✓		
Swallow screen or assessment within 4 hours	Yes	Yes + No + Unknown + Missing		✓	✓	✓	✓		
Swallow screen or assessment prior to oral intake	Yes	Yes + No + Unknown + Missing		✓	✓	✓	✓		✓
Mobilised during episode	Yes	Yes + No + Unknown + Missing		✓			✓		
Mobilised same day or day after arrival	Yes	Yes + No + Unknown + Missing		✓			✓		
Discharged on antihypertensive medications	Yes	Yes + No + Unknown + Missing	Includes discharged patients without contraindications	✓	✓	✓	✓	✓	
Discharged on antithrombotic medications	Yes	Yes + No + Unknown + Missing	Includes discharged patients without intracerebral haemorrhage or contraindications	✓	✓	✓	✓		
Discharged on lipid-lowering medications	Yes	Yes + No + Unknown + Missing	Includes discharged patients without intracerebral haemorrhage or contraindications	✓	✓	✓	✓		
Care plan provided if discharged to the community	Yes	Yes + No + Unknown + Missing	Includes patients discharged home or to a residential aged care facility	✓	✓	✓	✓	✓	

* All indicators exclude data from hospitals where >30% of data for the relevant indicator are missing.

APPENDIX K:
COVID-19 REPORTING GROUP

The main writing committees for the two papers included:

Dominique A. Cadilhac, Joosup Kim, Geoffrey Cloud, Craig S. Anderson, Emma K. Tod, Sibilah J. Breen, Steven Faux, Timothy Kleinig, Helen Castley, Richard I. Lindley, Sandy Middleton, Bernard Yan/ Peter Mitchell, Kelvin Hill, Brett Jones, Darshan Shah/ Rohan Grimley, Katherine Jaques, Benjamin Clissold, Bruce Campbell, Natasha A. Lannin.

The following AuSCR collaborators contributed to the interpretation of data, critical revision of drafts of the COVID-19 impacts on stroke care articles, and/or collection of data (in alphabetical order):

Alaa Alghamry (The Prince Charles Hospital, QLD)

Lauren Arthurson (Echuca Regional Health, VIC)

Jonnel Boco (Caboolture, QLD)

Melanie Brown (Goulburn Valley Health, VIC)

Helen Brown (Princess Alexandra Hospital, QLD)

Ernie Butler (Peninsula Health, VIC)

Greg Cadigan (QLD Health, QLD)

Anna Clissold (South West Healthcare, VIC)

Janell Cole (North West Regional Hospital, TAS)

Douglas Crompton (Northern Health, VIC)

Vanessa Crosby (Albury Wodonga Health, VIC & NSW)

Geoffrey Donnan (University of Melbourne, VIC)

Angela Dos Santos (Alfred Health, VIC)

Ramesh Durairaj (Cairns Hospital, QLD)

Chris Ebersohn (Wimmera Base Hospital, VIC)

Andrew Evans (Westmead Hospital, NSW)

Brett Forge (West Gippsland Hospital, VIC)

Karen Fuller (Wollongong Hospital, NSW)

Nisal Gange (Toowoomba Hospital, QLD)

Yash Gawarikar (Calvary Hospital, ACT)

Richard Geraghty (Redcliffe Hospital, QLD)

Rohan Grimley (Sunshine Coast University Hospital, QLD)

Susan Hillier (University of South Australia, SA)

Kate Jackson (Agency for Clinical Innovation, NSW)

Martin Jude (Wagga Wagga Hospital, NSW)

Salman Khan (Nepean Hospital, NSW)

Monique Kilkenny (Monash University, VIC)

Thomas Kraemer (Ballarat Base Services, VIC)

Alex Lau (Logan Hospital, QLD)

Henry Ma (Monash Health, VIC)

Krishna Mandaleson (Central Gippsland Health Service, VIC)

Romesh Markus (St Vincent's Hospital, NSW)

Peter Mitchell (Royal Melbourne Hospital, VIC)

Stephen Moore (Lismore Base Hospital, NSW)

Julie Morrison (The Florey Institute of Neuroscience and Mental Health, VIC)

Neha Nandal (Mackay Base Hospital, QLD)

Kim Parrey (Port Macquarie Hospital, NSW)

Lauren Pesavento (Melbourne Health, VIC)

Juan Rois-Gnecco (Ipswich, QLD)

Darshan Shah (Gold Coast University Hospital, QLD)

Daniel Schweitzer (Mater Hospital Brisbane, QLD)

Amanda Siller (Queen Elizabeth II Jubilee Hospital, QLD)

Jenni Steel (Port Macquarie Hospital, NSW)

Karen Stephens (Eastern Health, VIC)

Louise Starkie (Hamilton Base Hospital, VIC)

Meng Tan (Gold Coast University Hospital and Robina Hospital, QLD)

Vincent Thijs (Austin Health, VIC)

Dinesh Tryambake (Launceston General Hospital, TAS)

Rebecca Weir (Northeast Health Wangaratta, VIC)

Leanne Whiley (Rockhampton Hospital, QLD)

Richard White (Townsville Hospital, QLD)

Tissa Wijeratne (Western Health, VIC)

Matt Willcourt (Flinders Medical Centre, SA)

Nigel Wolfe (Blacktown Hospital, NSW)

Andrew Wong (Royal Brisbane and Women's Hospital, University of Queensland, QLD)

Peter Wood (Bundaberg Hospital & Hervey Bay Hospital, QLD)

Jorge Zavala (Alfred Health, VIC)

APPENDIX L: SUMMARY OF EMERGENCY DEPARTMENT DATA

Additional Table I: Baseline and clinical characteristics of adult patients in the ED Dataset

	N=312 adult patients
	n (%)
Age in years, mean (SD)	68 (16)
Age in years, median (Q1 to Q3)	72 (59 to 80)
Female	138 (44)
Born in Australia	205 (66)
Aboriginal and/or Torres Strait Islander	6 (2)
	N=313 adult episodes
Clinical diagnosis	
Ischaemic Intracerebral haemorrhage Transient ischaemic attack Undetermined	244 (78) 52 (17) 7 (2) 8 (3)
Able to walk on admission*	50 (17)
National Institutes of Health Stroke Scale (NIHSS) categories	
No stroke symptoms (0) Minor stroke (1-4) Moderate stroke (5-15) Moderate to severe stroke (16-20) Severe stroke (21-42) Missing	12 (4) 48 (15) 113 (36) 57 (18) 27 (9) 56 (18)
Modified Rankin Scale prior to stroke	
0 – No symptoms at all 1 – No significant disability despite symptoms 2 – Slight disability 3 – Moderate disability 4 – Moderately severe disability 5 – Severe disability Missing	218 (70) 55 (18) 23 (7) 10 (3) 0 (0) 3 (1) 4 (1)
Triage category	
1 2 3 4 5 Missing	62 (20) 219 (70) 22 (7) 9 (3) 0 (0) 1 (<1%)

SD: standard deviation; Q1: 25th percentile; Q3: 75th percentile.
* Excludes missing responses (8%).

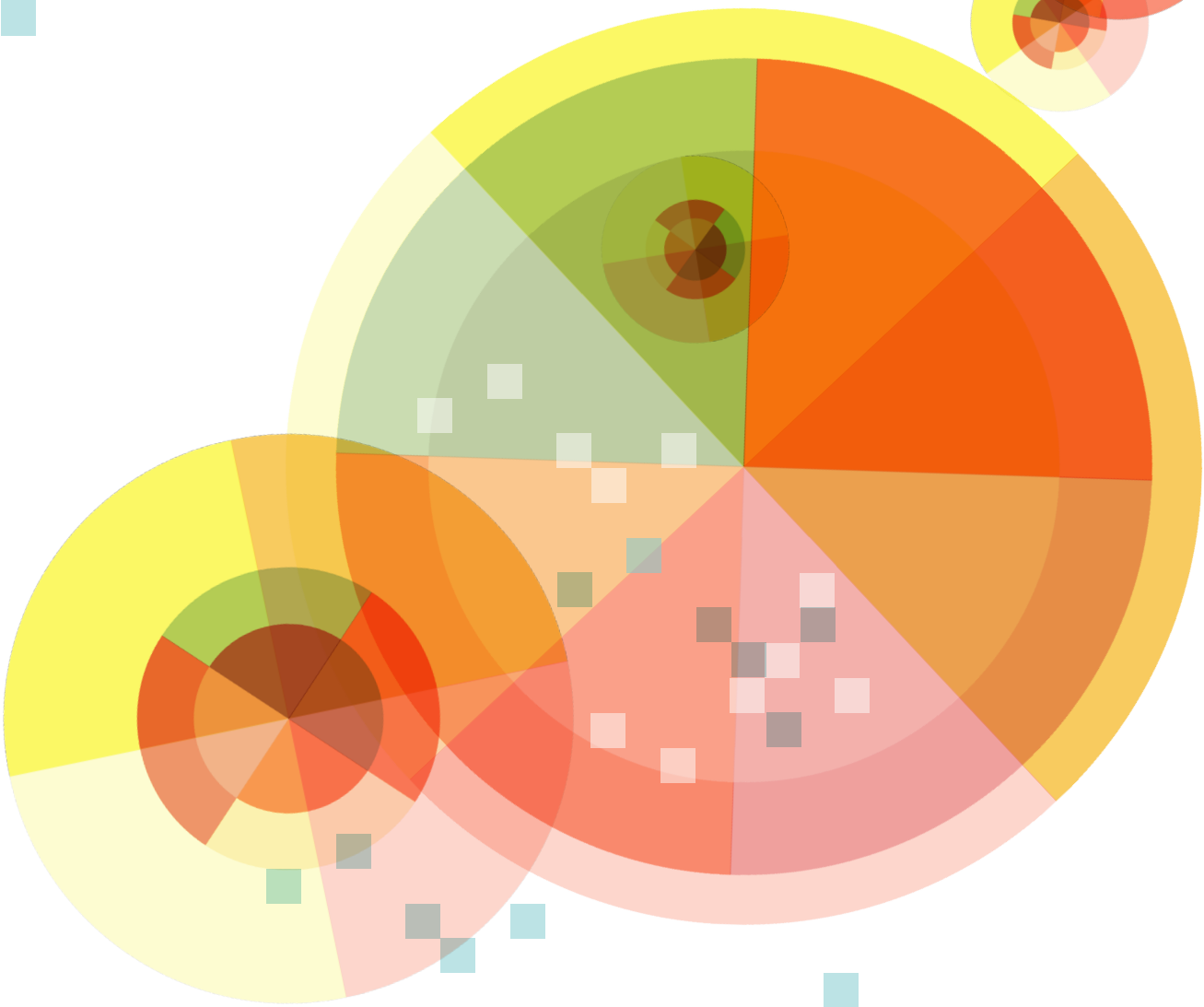
Additional Table II: Care provision in the Emergency Department and reason for transfer

	N=313 adult episodes
	n (%)
Arrival by ambulance	262 (84)
Arrival within 4.5 hours of symptom onset	189 (60)
Pre-hospital notification by paramedics	145 (46)
Brain scan after stroke*	295 (99)
Advanced Imaging Performed	
CT angiography	276 (88)
CT perfusion	208 (66)
Diffusion weighted imaging	3 (1)
MR angiography	2 (1)
Perfusion weighted imaging	7 (2)
None	26 (8)
Median time to brain scan (Q1 to Q3)*	19 (10 to 40)
Provision of thrombolysis if ischaemic stroke	109 (46)
Adverse event related to thrombolysis occurred	6 (5)
Telemedicine consultation	186 (59)
Swallow screen conducted	40 (15)
Swallow screen prior to oral intake	88 (34)
Reason for transfer	
Need for intravenous thrombolysis	0 (0)
Need for stroke unit care	47 (15)
Need for specialist medical assessments	86 (27)
Need for surgical interventions	60 (19)
Need for diagnostic tests	32 (10)
Need for endovascular therapy	210 (67)
Unknown	6 (2)
Other	28 (9)

CT: computed tomography; MR: magnetic resonance.
* Excludes missing responses (<7%).

APPENDIX M: ABBREVIATIONS

ABC™	Achievable benchmarks of care
ACT	Australian Capital Territory
AF	Atrial fibrillation
APF	Adjusted performance fraction
ASC	Australian Stroke Coalition
ASGS	Australian Statistical Geography Standard
AuSCR	Australian Stroke Clinical Registry
AuSDaT	Australian Stroke Data Tool
ECR	Endovascular clot retrieval
ED	Emergency Department
EQ-5D-3L™	European Quality of Life - five dimension three level instrument
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
PROMs	Patient reported outcome measures
QI	Quality improvement
RAMR	Risk adjusted mortality rate
SA	South Australia
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
VAHI	Victorian Agency for Health Innovation
VAS	Visual Analogue Scale
VIC	Victoria
VSCN	Victorian Stroke Clinical Network
VST	Victorian Stroke Telemedicine
WA	Western Australia



AuSCR

Australian Stroke Clinical Registry