National Stroke Audit

Acute Services Report 2021

strokefoundation.org.au

About the Stroke Foundation

The Stroke Foundation is a national charity that partners with the community to prevent, treat and beat stroke. We stand alongside stroke survivors and their families, healthcare professionals and researchers. We build community awareness and foster new thinking and innovative treatments. We support survivors on their journey to live the best possible life after stroke. We are the voice of stroke in Australia, and we work to:

- Raise awareness of the risk factors, signs of stroke and promote healthy lifestyles.
- Improve treatment for stroke to save lives and reduce disability.
- Improve life after stroke for survivors.
- Encourage and facilitate stroke research.
- Advocate for initiatives to prevent, treat and beat stroke.
- Raise funds from the community, corporate sector, and government to continue our mission.

About the National Stroke Audit

The National Stroke Audit is a Stroke Foundation initiative and is part of its commitment to promote the delivery of evidence-based stroke care. The National Stroke Audit provides longitudinal data on clinical performance. The National Stroke Audit first commenced in 2007 and each alternate year the Stroke Foundation switches focus between inpatient rehabilitation services and acute stroke services.

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Note: The National Stroke Audit – Acute Services 2021 Report and additional documents are available at:
www.informme.org.au/stroke-data

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Foreword

On behalf of Stroke Foundation and our Clinical Council, I present the National Stroke Acute Audit Service Report. The National Stroke Audit continues to provide important insights into the care provided by acute stroke hospital services across Australia.

One in four people globally will have a stroke in their lifetime and incidence of stroke among younger Australians is increasing. The good news is advancements in stroke treatment mean more Australians are surviving stroke. The 2021 National Stroke Audit Acute Services highlights positive improvements that have been made. However, there is still a way to go.

Regional and rural Australians are continuing to be the poor cousins of their city counterparts with lower access to standard emergency stroke treatments simply because of where they live. This is especially concerning because rural and regional Australians have a greater stroke risk.

The Australian Government is leading the way with the development of the National Strategic Action Plan for Heart and Stroke. Key actions in the Plan are to improve access to emergency stroke treatment through telehealth and clinical pathways. Data from this report demonstrate the benefits of formal telestroke services in regional and rural Australia. Fortunately, most states have committed to funding acute telestroke services, however, governments must now work together to enable all Australians benefit from the advances that a national telestroke network can realise.

2021 has been an unprecedented year but despite the challenges of a pandemic, we saw continued support and participation in the National Stroke Audit. Thank you to the many health professionals and health services for their time and for their commitment to improving stroke services in Australia.

Results of this year's Audit provide insights into Australian stroke services and the health system more broadly within the shadows of the coronavirus (COVID-19) pandemic. Those affected by stroke were impacted by the diversion of resources within our health system to manage the pandemic, but many indicators of quality remained stable or even improved in the face of this challenge. However, there appears significant impact on the timeliness of accessing clot-busting medication, where we now lag even further behind international peers. We must ensure this area improves as 'time is brain' and slow treatment is impacting long-term recovery.

Overall, it is pleasing to see the quality of stroke care can improve in the face of this challenge. With this data, we must collectively strive to do more to support those impacted by stroke and their families to become well and live a full life after stroke.

Sharon McGowan
Chief Executive Officer
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Executive Summary

Stroke has a major impact in the lives of a significant number of Australians.[1] Stroke Foundation's 2021 National Stroke Audit – Acute Services report is the 8th national report on the status of inpatient acute stroke services. It is part of Stroke Foundation's broader National Audit program delivered as part of our commitment to promoting evidence-based stroke care. The National Stroke Audit first commenced in 2007 and each alternate year, the audit switches focus between acute stroke services and inpatient rehabilitation services.

It provides a robust and representative assessment of inpatient acute services in Australia. The report aims to highlight areas where the system is working well, and where improvements or changes are needed. The ability to participate in routine quality improvement activities, including the National Stroke Audit, was impacted due to the COVID-19 pandemic, although encouragingly participation in the 2021 audit remained strong.

Results of the 2021 National Stroke Audit – Acute Services report provide an important snapshot in time. It monitors the performance of stroke care against evidence-based Acute Stroke Clinical Care Standard Indicators (2019)[2] and the National Acute Stroke Services Framework (2019).[3]

In 2021, twelve Australian hospitals – all located in major cities within six states and territories – met all 20 elements of a comprehensive stroke centre, ensuring they were equipped to deliver leading-edge care. This includes the provision of hyperacute care 24 hours a day, seven days a week. Hyperacute care is also referred to as reperfusion therapies, which are endovascular thrombectomy [clot removal] services and thrombolysis [clot dissolving] services. This is an increase from the ten comprehensive stroke centres in five states reported in the previous (2019) National Acute Audit.

However, neither Tasmania nor the Northern Territory has a comprehensive stroke centre.

Further, the Audit report again highlights inconsistencies within states and territories in the care provided to those impacted by stroke. Hospitals in major cities were found to meet on average 17/20 recommended elements, whereas hospitals from inner regional areas met 15/20 elements and those from outer regional areas met 12/20. All Australians need and deserve access to best-practice care; recovery from stroke should not be determined by where you live and your access to specialist services.

More than 40% of patients will experience a warning prior to their stroke.[4] A transient ischaemic attack (TIA) happens when the blood supply to your brain is blocked temporarily. The signs are the same as for a stroke, but they disappear within a brief time. A patient's risk of a stroke is highest in the first few days immediately following a TIA. However, a stroke may be avoided if risk factors are managed in line with Clinical Guidelines.

The vast majority (86%) of services report a defined process, policy, or pathway for patients diagnosed with a TIA. However, the average wait time to be reviewed and provided essential preventative treatment in a dedicated TIA clinic was five days – well below the guideline-recommended two days, and after the time most subsequent strokes will have occurred.

'Time is brain' therapies

When a stroke strikes it can destroy 1.9 million brain cells per minute,[5] therefore 'time is brain'. Reperfusion therapies can stop this damage if delivered quickly after stroke. Many people can recover from stroke, but this depends on someone calling 000 immediately, early arrival of paramedics who are trained in acute stroke protocols, and the adoption of early 'code stroke' notification to the receiving hospital.

Similar to the findings from the 2019 audit, only 37% of all patients with acute stroke reached hospital within the critical 4.5-hour time window for thrombolysis treatment. Our results indicate not enough Australians are aware that stroke is a time-critical medical emergency.

Reperfusion therapies are used to dissolve clots in patients with the most common type of stroke (an ischaemic stroke). Reperfusion treatments, intravenous (IV) thrombolysis and/or endovascular thrombectomy, have increased across Australia being delivered to a total of 4,899 patients in 2021 (~7% increase from 4,555 reported in 2019).

More hospitals report the availability of thrombolysis treatment, 88% in 2021 compared to 82% in 2019. But increased availability has not led to an increase in access to this therapy for patients with stroke. The overall average use of thrombolysis in the clinical audit has remained unchanged at 11% nationally, with a reported total of 2,705 treatments provided, consistent with 2,649 reported in 2019.

Of concern is the speed of delivering reperfusion therapies, with fewer than one in three patients receiving thrombolysis within 60 minutes of hospital arrival (well below rates achieved in other countries with similar developed health systems such as UK and US).

Thrombolysis provision was lower in inner regional hospitals (11%) and outer regional hospitals (6%) compared to hospitals in major cities (13%). Acute telehealth services were found to improve the rate of thrombolysis for regional services (11% compared to 8%) and improve prompt hospital arrival and earlier initiation of this life-saving therapy.

Endovascular thrombectomy

Endovascular thrombectomy benefits patients with the biggest clots and subsequent worse strokes. It is currently available as a treatment at 20 major city locations nationally; 15 of these provide the treatment 24 hours a day, seven days a week. It is encouraging to see continued increase in delivery of endovascular thrombectomy, rising from 1,907 patients in 2019 to 2,194 in 2021 (15% increase in reported number of endovascular clot retrieval procedures performed).

The Stroke Foundation recognises endovascular thrombectomy is a specialist procedure requiring a specialist team, trained interventionists, and sophisticated imaging equipment. It is not practical to have the treatment available at all health services treating stroke. However, there is potential for all Australians to access this treatment if early stroke diagnosis and patient transfer pathways are in place with the nearest comprehensive stroke centre.

Based on the benchmark set by high-performing services, a thrombolysis rate of almost 30% of all patients with ischaemic stroke is achievable. With Australian hospitals reporting only a 11% thrombolysis rate, thousands of patients are missing out on treatments that saves lives and reduce disability. Acute telehealth services in regional and rural locations are critical to improve access to thrombolysis and also assist in efficient referrals for endovascular thrombectomy.

Stroke unit care

In conjunction with time-critical treatments, access to stroke unit care is proven to deliver improved outcomes for patients.[6]

The number of stroke units increased in this year's Audit to 93 hospitals (81%) compared to 91 hospitals (76%) in 2019. Access to stroke unit care has improved (73% compared to 67% in 2019), however only just over half (54%) of patients remained on the stroke unit for 90% of their acute stay (this is well below the 84% of patients receiving stroke unit care in the UK). Stroke unit access is markedly lower in inner (41%) and outer (64%) regional hospitals compared to major city hospitals (84%).

All primary and comprehensive stroke services are recommended to have clear medical and nursing leadership, involvement of a comprehensive allied health team and a dedicated stroke coordinator role. Almost all (92%) services report a dedicated multidisciplinary team with members who have a special interest in stroke. However, 24 (21%) hospitals reported no medical lead principally responsible for stroke care, and nine stroke unit hospitals reported no medical stroke lead. Furthermore, 35 (30%) hospitals, of which 22 were stroke unit hospitals, do not have a dedicated stroke coordinator – a critical role in assisting the team to deliver best practice care.

Starting on the road to recovery

Assessment of stroke patients within 48 hours of hospital arrival by physiotherapy, occupational therapy and speech pathology all improved in this audit. Patients treated on a stroke unit were more likely to be assessed by a physiotherapist within 48 hours of arrival (84% in stroke unit compared to 70% not treated in a stroke unit).

Improvements in swallow screening within 4 hours (30%), mood assessment (32%) and incontinence management (38%) are also noted. However, the fact that less than half of all patients received these important interventions highlights significant gaps in care that require further focus.

Early rehabilitation and appropriate assessment of ongoing rehabilitation needs is a critical component of best-practice stroke care. Services must also coordinate with rehabilitation services to facilitate seamless transfer of care for people with stroke. Positively, most services (92%) reported coordination between acute and rehabilitation services. Of the 67% patients assessed for rehabilitation, 69% of patients were found to have ongoing rehabilitation needs. With over two thirds of patients requiring ongoing rehabilitation, it

is concerning that 33% of patients missed an initial rehabilitation assessment. Again, patients treated on a stroke unit were significantly more likely to have an assessment for rehabilitation (74% compared with 47%). Those treated in major city hospitals were more likely to be assessed than hospitals in inner or outer regional areas (71% cities vs 63% inner regional vs 56% outer regional).

A greater focus on identifying and addressing patient rehabilitation needs is required.

Helping patients to live well after stroke

For treatments to be capitalised upon, patients and their families need support and advice in the critical transition phase from acute hospital to inpatient rehabilitation or to their home.

Discharge care plans, developed with patients and their families, have long been emphasised in Clinical Guidelines and advocated by people with lived experience of stroke. Only 76% of patients received a comprehensive discharge care plan. This was an improvement compared to previous years (69% in 2019), but more must be done. Patients in stroke units were more likely to have access to a discharge care plan (80% vs 62%), further highlighting the benefits of dedicated stroke services.

Disappointingly, the 2021 audit showed that patients were being discharged from hospital without this vital support to reduce their risk of having another stroke. Twenty-two percent of patients were not given advice on lifestyle and other modifiable risk factors to avoid another stroke and 22% were not prescribed recommended secondary prevention medications (blood pressure lowering or oral anticoagulation for patients with atrial fibrillation).

Carers are often forgotten in the transition to home or to a rehabilitation service. Almost one in three (29%) audited cases reported the presence of a carer where this was deemed to be required (those with moderate to severe disability), with just over half of these cases going on to inpatient rehabilitation. However, of the carers of patients who were discharged from acute hospital care, 35% were inadequately assessed for their needs, or trained in ways to support the stroke survivor outside of hospital. This result is like previous audits and thus occurred prior to the impact of COVID-19. Greater attention is needed to tailored support programs to better prepare carers for their roles.

Again, support in the transition home was more likely to be provided where patients were treated in a stroke unit. This means patients treated outside of stroke units were again disadvantaged.

Scope for improvement

Overall, the data in this Audit Report outline gains in several areas when contrasted to prior audits, even with the backdrop of the COVID-19 pandemic. Certainly, this context is likely to partly explain the slower thrombolysis timeframes, but other non-COVID factors need to be explored. Significant variation across states and territories remains a concern, but also provides an opportunity for targeted quality improvement programs.

Recommendations

› Increase awareness of the signs of stroke and that stroke is a time-critical medical emergency.

› Improve equity of access to reperfusion therapies especially in regional, rural and remote areas. Formal policies and pathways across the whole healthcare system are needed to connect dedicated stroke centres to other hospitals via telehealth.

› Improve earlier access to thrombolysis to match international benchmarks.

› Improve access to dedicated stroke unit care and ensure most of the acute care is provided within this unit. Stroke unit teams must have clear medical leadership and a dedicated stroke care coordinator who are actively involved in care.

› Improve holistic patient care including a greater focus on swallow screening, mood assessment and management of incontinence.

› Ensure carers are assessed, trained, and connected to community support prior to patient discharge.

› Ensure all patients are supported through comprehensive discharge processes including a thorough assessment for rehabilitation and a holistic patient-centred discharge care plan.

2021 at a glance

> 115 Hospitals   > 35,652 Acute stroke admissions
> 3890 stroke cases audited

Time critical stroke therapy

37%

Of patients reached hospital in a 4.5 hour time window for time-critical emergency treatment (36% in 2017; 35% in 2019)

Use of thrombolysis has stagnated

11%
2017

10%
2019

11%
2021

Thrombolysis in **60 MINUTES** (door-to-needle)

27% 2021

Door-to-needle within **60 MINUTES** lags internationally

80%   **61%**

Stroke unit care

67%
STROKE ACCESS 2019

73%
STROKE ACCESS 2021

84%
Metro
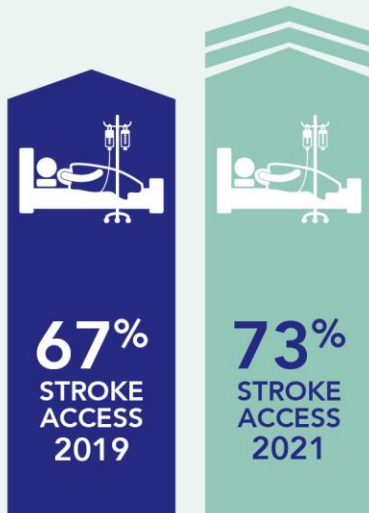
Patients who received stroke unit care

41%
Regional

Routine use of Clinical Guidelines

75%
in hospital **WITH** stroke unit

36%
in hospital **WITHOUT** stroke unit

Patients had a care plan developed with the team before discharge

80%
in hospital **WITH** stroke unit

62%
in hospital **WITHOUT** stroke unit

More patient care needed

24%
of patients did **not** receive a
DISCHARGE CARE PLAN

33%
of patients did **not** receive a
REHABILITATION ASSESSMENT

22%
of patients did **not** receive
RISK FACTOR EDUCATION
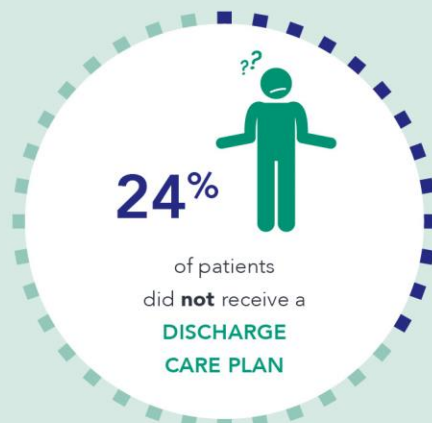
Chapter 1: Introduction

Stroke is one of Australia's biggest killers and a leading cause of disability.[7] Stroke kills more women than breast cancer and more men than prostate cancer. In 2020 there were estimated to be 27,428 people who experienced stroke for the first time – that is, one stroke every 19 minutes.[1] More than 445,000 people are living with the effects of stroke,[1] with around 24% of first-ever strokes occurring in people aged 54 years and under.[2] The direct financial cost of stroke in Australia is estimated to be $6.2 billion each year.[8]

1.1 Clinical Guidelines and the National Stroke Audit

The Stroke Foundation has coordinated the development of national Clinical Guidelines for stroke care since 2003. Clinical guidelines empower clinicians in understanding the best evidence-based interventions to help people recover from stroke. The *Clinical Guidelines for Stroke Management*[9] are approved by the National Health and Medical Research Council (NHMRC) and help to form the basis of the National Stroke Audit, determining what essential clinical care data should be collected. The National Stroke Audit was designed by the Stroke Foundation in consultation with experts to monitoring stroke care at nationwide and state-wide levels.

Clinical guidelines are only useful when they are used effectively in clinical practice. An important strategy to encourage change to be in line with what is known to be best practice, is an 'audit and feedback' process. The National Stroke Audit promotes quality improvement through a tailored report provided back to individual hospital services. These individualised reports enable teams to compare their performance against national averages, achievable benchmarks obtained from the top-performing services, and peers based on other similar-sized (admissions per year) stroke services.

1.2 The National Stroke Audit Program

The National Stroke Audit program commenced in 2007 and provides longitudinal, cross-sectional data to track changes over time, allowing services to understand where they have, and have not, improved between each National Stroke Audit.

The methods for the audit are outlined in Appendix but in essence the National Stroke Audit – Acute Services comprises two components (Figure 1):

- An Organisational Survey of acute hospital services across Australia. The Organisational Survey provides information about the resources available to deliver acute stroke care such as the availability of stroke units, imaging services and interdisciplinary staff. The Organisational Survey questions assess the adherence to the *National Acute Stroke Services Framework 2019*[3] (the Framework) which provides national recommendations related to acute stroke elements of care including what defines a stroke unit, Comprehensive Stroke Centre, Primary Stroke Centre and General Hospital services.

- A Clinical Audit involving the retrospective review of up to 40 consecutive patients. Eligible patients must be admitted to, and discharged from, the participating service between 1 July – 31 December 2020. The Clinical Audit specifically reports against the indicators *Acute Stroke Clinical Care Standard 2019*[2] and is used to measure the adherence to evidence-based processes of care such as timely assessments by clinicians, diagnostic procedures, early interventions, interdisciplinary care, and discharge planning as recommended in the *Clinical Guidelines for Stroke Management.*[9]

Figure 1: Components of acute care reflected in this report

National Acute Stroke Services Framework 2019 (the Framework)	*Acute Stroke Clinical Care Standard 2019* and *Clinical Guidelines for Stroke Management*[4]
⬇	⬇
Outlines recommended resources in acute stroke	Outlines recommended clinical care in acute stroke
⬇	⬇
Measured by the Organisational Survey	Measured by the Clinical Audit
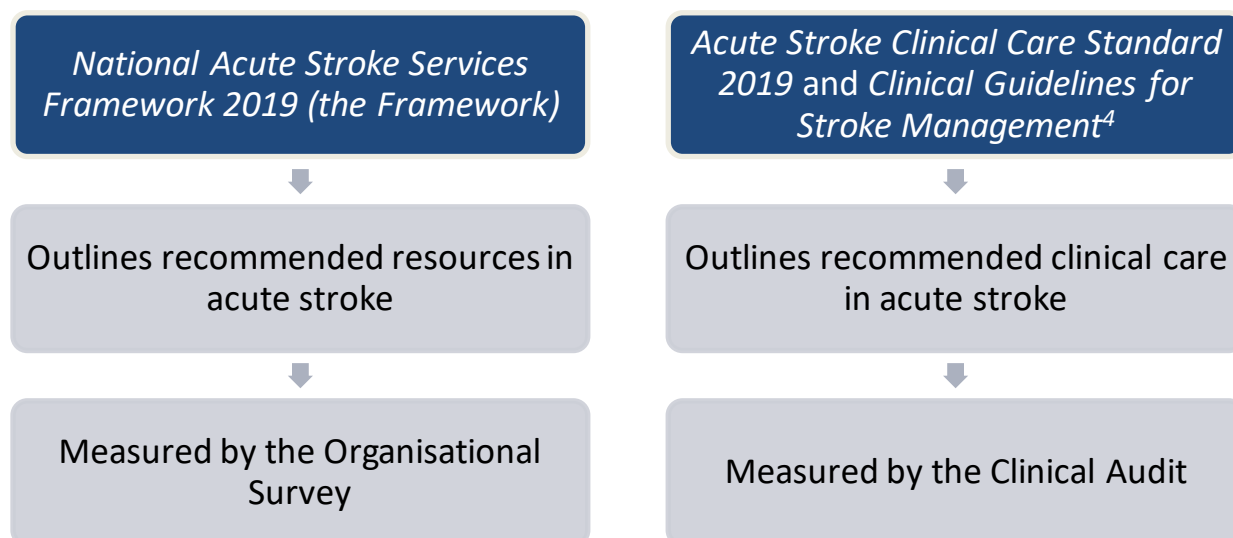
The National Stroke Audit – Acute Services is conducted biennially to provide standardised, cross-sectional data on clinical performance. Each alternate year, the Stroke Foundation undertakes an audit of inpatient rehabilitation services for patients with stroke.

1.3 Structure of the report

For this report, 'acute care' refers to care provided following a new stroke event in hospital, from arrival to discharge from the acute care service, statistical discharge to a different ward/unit in the same service, or transfer to inpatient rehabilitation.

This report outlines the resources and structures available at the participating stroke services mapped to the Framework, as well as adherence to the Australian Commission of Safety and Quality in Health Care's (ACSQHC) *Acute Stroke Clinical Care Standard 2019*[3] and the *Clinical Guidelines for Stroke Management.*[9]

- Chapter 2 includes details of the participating acute services.
- Chapter 3 covers the stroke service responses to the Organisational Survey.
- Chapter 4 provides results of the Clinical Audit, which reflects individual patient care.
- Chapter 5 demonstrates the changes in stroke care delivered over three acute audit cycles.
- Chapter 6 includes discussion and recommendations from analysing and interpreting the results.

Chapter 2: Participating Acute Hospital Services

Acute hospital services were identified nationwide based on a criterion of:
   a) admitting at least 40 patients with acute stroke in a year,
   b) previous participation, and
   c) in consultation with state-based clinical networks.

2.1 Defining remoteness areas

Classification of participating services as metropolitan or regional/rural was based on the Accessibility and Remoteness Index of Australia (ARIA+). The Australian Statistical Geography Standard (ASGS) defines remoteness areas into 5 classes of relative remoteness across Australia (refer to Appendix). The participating audit services fall into four classes of remoteness:

- Major Cities of Australia
- Inner Regional Australia
- Outer Regional Australia
- Remote Australia

There was only one participating remote service, and this has been categorised as an Outer Regional service for these data analyses.

2.2 Participating acute service characteristics

The 111 eligible public services, and four private services (Table 1), that completed the Organisational Survey reported a total of 35,652 annual acute stroke admissions (Table 2) in the previous calendar year (2020). Based on admissions reported provides a good representation of current acute inpatient experiences across Australia.

Table 1: Participating services by location and region

	Organisational Survey			Clinical Audit		
	Total	**Public**	**Private**	**Total**	**Public**	**Private**
Australia	**115**	**111**	**4**	**104**	**102**	**2**
Australian Capital Territory (ACT)	2	2	0	2	2	0
New South Wales (NSW)	38	37	1	34	33	1
Northern Territory (NT)	2	2	0	2	2	0
Queensland (QLD)	25	24	1	21	21	0
South Australia (SA)	6	6	0	5	5	0
Tasmania (TAS)	3	3	0	3	3	0
Victoria (VIC)	28	26	2	27	26	1
Western Australia (WA)	11	11	0	10	10	0
Region*						
Major Cities	62	58	4	58	56	2
Inner Regional	37	37	0	33	33	0
Outer Regional^	16	16	0	13	13	0

*Rurality by ARIA+ classification: Accessibility and Remoteness Index of Australia
^Outer Regional classification includes one Remote stroke service

Smaller services that reported 74 or fewer annual acute stroke admissions (N=21) accounted for 918 (2.6%) of all reported admissions. Services admitting 500 or more patients with acute stroke per year (N=20) reported admitting 16,416 patients (46%). The 104 services participating in the Clinical Audit managed 34,981 admissions in 2020, or 98% of the reported caseload from the Organisational Survey.

Table 2: Participating services by state, region, and annual stroke admissions

	Total annual stroke admissions	Participating services by annual stroke admissions				
		<75	75-199	200-349	350-499	≥500
Australia (N=115)	**35,652**	**21**	**29**	**27**	**18**	**20**
ACT (N=2)	605	0	0	1	1	0
NSW (N=38)	11,605	5	7	13	5	8
NT (N=2)	319	0	1	1	0	0
QLD (N=25)	6432	6	8	5	3	3
SA (N=6)	2704	2	1	0	1	2
TAS (N=3)	965	0	1	1	1	0
VIC (N=28)	10,139	4	9	4	6	5
WA (N=11)	2883	4	2	2	1	2
Region						
Major Cities (N=62)	27,311	5	11	11	15	20
Inner Regional (N=37)	6518	9	12	14	2	0
Outer Regional (N=16)^	1823	7	6	2	1	0

^Outer Regional classification includes one Remote stroke service

The number of patients with stroke admitted per service (Table 3) in the Organisational Survey ranged from 10 to 1597 (median: 239; Q1: 105; Q3: 422).

Table 3: Participating services by size and capacity, by state and region

	Total number of acute service beds	Median number of acute beds per service (Q1, Q3)	Median number of annual stroke admissions (Q1, Q3)
Australia (N=115)	**37,521**	**264 (141, 488)**	**239 (105, 422)**
ACT (N=2)	854	427 (254, 600)	303 (200, 405)
NSW (N=38)	13,564	318 (195, 468)	259 (126, 422)
NT (N=2)	525	263 (180, 345)	160 (80, 239)
QLD (N=25)	7852	249 (172, 499)	180 (116, 261)
SA (N=6)	1864	244 (72, 593)	296 (50, 642)
TAS (N=3)	751	264 (103, 384)	320 (172, 473)
VIC (N=28)	8799	244 (113, 473)	230 (106, 445)
WA (N=11)	3312	182 (100, 488)	162 (34, 427)
Region			
Major Cities (N=62)	28,398	443 (311, 600)	387 (190, 612)
Inner Regional (N=37)	6573	150 (93, 220)	171 (79, 260)
Outer Regional (N=16) ^	2550	95 (57, 176)	82 (43, 151)

Q1: 1st quartile; Q3: 3rd quartile
^Outer Regional classification includes one Remote stroke service

Chapter 3: Organisational Survey Results

This section of the report describes the current resources reported to be available in participating Australian services to support best-practice stroke care, mapped to the Framework elements.

The aim of the Framework is to:
- Outline where stroke services should be developed and what they should include, to assist planning of stroke services.
- Provide a basis for measuring adequacy of current structures and resources for best-practice stroke care.
- Provide information to advocate for improved services where gaps are identified.
- Guide decisions about resource requirements (including minimum stroke unit bed numbers in comprehensive stroke centres).
- Provide an outline for monitoring quality of care delivered by stroke services.

The Framework comprises 20 elements (refer to Table 5 for a list of elements). The number of elements met reflects the service level provided at the acute stroke service. Therefore, a Comprehensive Stroke Centre (CSC) would have obtained all the Framework elements. A Primary stroke centre (PSC) should have most elements, and where they do not, they should have processes in place to transfer patients to a CSC for specialised care.

Key findings:
- There were 12 stroke services classified as a Comprehensive Stroke Centre (CSC) across Australia (increase from 10 in 2019).
- Increase in the national median number of the Framework elements met to 16 elements (from 15 in 2019).
- More services offered intravenous thrombolysis (also referred to as thrombolysis) - increase from 82% (2019) to 88% (2021).
- There has been a 15% rise in the number of endovascular thrombectomy procedures (also referred to as endovascular clot retrieval) performed (1907 in 2019 to 2194 in 2021).
- Thrombolysis numbers, however, are similar (2649 in 2019; 2705 in 2021).
- Ten services admitting ≥75 strokes annually do not have a dedicated stroke unit (as per the Framework recommendations).
- Increase in services using telehealth to coordinate care from 72% in 2019 to 76% in 2021.

3.1 Overall adherence to the Framework

The median number of the Framework elements met by the 115 services completing the Organisational Survey was 16 out of the 20 elements (Table 4). Twelve services (10%) met all 20 elements and were therefore considered to be a CSC.

CSCs are services that have highly specialised resources and clinicians available 24 hours a day, 365 days a year. They can manage a large patient volume of annual stroke admissions, including the most complex presentations. They have a dedicated stroke unit, established and well-organised systems to link emergency services and hyperacute care, and coordinated processes for ongoing inpatient rehabilitation, secondary prevention, and community reintegration.

CSCs have timely neurovascular imaging and expert interpretation (including advanced imaging capability) and offer reperfusion therapies (thrombolysis and endovascular thrombectomy) 24 hours a day, 7 days a week (24/7), along with links to other specialist services. They also have a leadership role in establishing partnerships with other local services for supporting stroke care. There were no CSCs identified in the Northern Territory or Tasmania.

Table 4. Median number of the Framework elements met, by region and annual stroke admission numbers

	Australia (N=115)	Region^			Reported annual stroke admissions				
		Major Cities (N=62)	Inner Regional (N=37)	Outer Regional (N=16)	<75 (N=21)	75-199 (N=29)	200-349 (N=27)	350-499 (N=18)	500+ (N=20)
Median number of Framework elements met	16	17	15	12	11	14	16	17	19
(Q1, Q3)	(12, 17)	(15, 18)	(12, 17)	(10, 16)	(8, 12)	(12, 17)	(14, 17)	(16, 18)	(17, 20)

Q1: 1st quartile; Q3: 3rd quartile
Framework: National Acute Strokes Framework 2019
^Outer Regional classification includes one Remote stroke service

Figure 2 below shows the progress in Australia's aggregated adherence to the 20 individual elements of the Framework.

Figure 2. Australia's aggregated adherence to the Framework elements; 2019 vs 2021

Element	2019	2021
Receive pre-notification of potential stroke patient	74%	81%
Coordinated emergency department systems	73%	81%
Stroke unit	76%	81%
Rapid access to onsite CT brain (24/7)	68%	77%
On-site endovascular thrombectomy (24/7)	11%	13%
On-site neurosurgical services	28%	28%
Delivery of thrombolysis	82%	88%
Ability to provide acute monitoring for at least 72 hours	96%	97%
Acute stroke team	92%	92%
Dedicated stroke coordinator position	67%	70%
Dedicated medical lead	74%	79%
Access to HDU/ICU (for complex patients)	93%	94%
Rapid TIA assessment clinics/services	47%	50%
Provision of telehealth services	72%	76%
Coordination with rehabilitation service providers	93%	92%
Standardised processes for rehabilitation assessment	83%	82%
Involvement of patients and carers in rehabilitation	100%	100%
Routine use of guidelines, care plans and protocols	58%	68%
Regular data collection and QI activities	91%	93%
Access and collaboration with other specialist services	68%	70%

Framework: National Acute Stroke Services Framework 2019;
CT: computerised tomography; 24/7: 24 hours a day, 7 days a week;
HDU: High Dependency Unit; ICU: Intensive Care Unit;
TIA: transient ischaemic attack; QI: quality improvement

3.2 State-wide implementation of the Framework

A systematic approach to resolving barriers that delay access to hyperacute stroke care is needed. The implementation of geographically appropriate models of emergency care should help achieve increased access to reperfusion therapies, ensure faster treatment delivery and improve access to stroke unit care across Australia.

It is imperative that those responsible for state-wide health system delivery work with the relevant pre-hospital emergency services to ensure a consistent approach to accessing stroke-capable centres in their jurisdiction. This should include state-wide protocols for transfer of suspected acute stroke patients to the initial hospital, secondary transfers for additional treatment and subsequent repatriation transfers for further acute, rehabilitation or palliative care services. In regional and rural areas, the use of telemedicine is strongly recommended to provide specialist assessment and management support to general hospital centres within agreed system of care.

Telemedicine support assists in deciding whether to transfer the patient for a higher level of care and interventions including endovascular thrombectomy. Telestroke is also applicable for stroke assessments including rehabilitation, remote therapy provision, and education and support following hospital discharge, reducing the need for patients and their families to travel long distances.

All eight states and territories stroke clinical network, or health department representatives, were asked four questions relating to the Framework recommendations:

- *Pre-hospital services*: 5/8 states have state-wide agreed arrangements with ambulance services (three states had partial agreements e.g., local hospital-specific).
- *Designated stroke-capable services:* 5/8 states have agreed state-wide services identified as PSC or CSC (or general hospital with telehealth support) that also have state-wide agreement/policies for transfers (the other three states had partial arrangements e.g., regional/local hospital-specific agreements).
- *Use of telestroke services for acute assessment and treatment*: 5/8 states have state-wide agreed telestroke services in general (non-stroke specialist) hospitals for decision-making around hyperacute care and/or transfers (two states had partial agreements e.g., during business hours or regional/local hospital-specific).
- *Use of telestroke services for rehabilitation assessment and treatment*: 1/8 states had agreed state-wide telestroke services for assessment and rehabilitation in general (non-specialist) hospitals (five states had partial agreements).

3.3 Adherence to the Framework by state

A summary of adherence to individual elements of the Framework for each state is shown in Table 5, excluding services not recommended to have dedicated stroke services (i.e., services with 74 or fewer annual stroke admissions or no stroke unit).

Table 5. Adherence to elements of the Framework, by location (services with ≥75 annual stroke admissions or a stroke unit)

Elements of the Framework	Australia (N=103)	ACT (N=2)	NSW (N=38)	NT (N=2)	QLD (N=20)	SA (N=5)	TAS (N=3)	VIC (N=25)	WA (N=8)
Receive pre-notification and prepare to rapidly accept potential strokes	84 (90%)	2 (100%)	30 (79%)	1 (50%)	15 (75%)	4 (80%)	2 (67%)	24 (96%)	6 (75%)
Coordinated ED systems	87 (84%)	2 (100%)	28 (74%)	2 (100%)	17 (85%)	4 (80%)	2 (67%)	24 (96%)	8 (100%)
Stroke unit	93 (90%)	2 (100%)	37 (97%)	1 (50%)	19 (95%)	4 (80%)	2 (67%)	22 (88%)	6 (75%)
Rapid access to on-site CT brain (24/7) including CT perfusion	85 (83%)	2 (100%)	31 (82%)	2 (100%)	16 (80%)	5 (100%)	2 (67%)	21 (84%)	6 (75%)
On-site endovascular thrombectomy (24/7)*	15	1	4	0	3	1	1	4	1
On-site neurosurgical services*	31	1	12	1	5	2	1	7	2
Delivery of intravenous thrombolysis	93 (90%)	2 (100%)	30 (79%)	2 (100%)	20 (100%)	5 (100%)	3 (100%)	24 (96%)	7 (88%)
Ability to provide acute monitoring for 72 hours	102 (99%)	2 (100%)	38 (100%)	2 (100%)	19 (95%)	5 (100%)	3 (100%)	25 (100%)	8 (100%)
Acute stroke team	99 (96%)	2 (100%)	37 (97%)	1 (50%)	20 (100%)	5 (100%)	2 (67%)	24 (96%)	8 (100%)
Dedicated stroke coordinator position	75 (73%)	2 (100%)	28 (74%)	1 (50%)	12 (60%)	3 (60%)	1 (33%)	22 (88%)	6 (75%)
Dedicated medical lead	88 (85%)	2 (100%)	31 (82%)	2 (100%)	17 (85%)	4 (80%)	2 (67%)	23 (92%)	7 (88%)
Access to HDU / ICU (for complex patients)	101 (98)	2 (100%)	37 (97%)	2 (100%)	19 (95%)	5 (100%)	3 (100%)	25 (100%)	8 (100%)
Rapid (within 48 hours) TIA assessment clinics/services	55 (53%)	2 (100%)	25 (66%)	1 (50%)	6 (30%)	3 (60%)	1 (33%)	12 (48%)	5 (63%)
Provision of telehealth services	77 (75%)	1 (50%)	27 (71%)	2 (100%)	14 (70%)	3 (60%)	2 (67%)	22 (88%)	6 (75%)
Coordination with rehabilitation service providers	99 (96%)	2 (100%)	35 (92%)	2 (100%)	20 (100%)	5 (100%)	3 (100%)	24 (96%)	8 (100%)
Standardised processes that ensure all stroke patients are assessed for rehabilitation	91 (88%)	1 (50%)	33 (87%)	2 (100%)	18 (90%)	5 (100%)	2 (67%)	23 (92%)	7 (88%)
Routine involvement of patients and carers in the rehabilitation process	103 (100%)	2 (100%)	38 (100%)	2 (100%)	20 (100%)	5 (100%)	3 (100%)	25 (100%)	8 (100%)
Routine use of guidelines, care plans and protocols	73 (71%)	2 (100%)	28 (74%)	1 (50%)	15 (75%)	2 (40%)	0 (0%)	20 (80%)	5 (63%)
Regular data collection and stroke specific quality improvement activities	102 (99%)	2 (100%)	38 (100%)	2 (100%)	20 (100%)	5 (100%)	3 (100%)	24 (96%)	8 (100%)
Access and collaboration with other specialist services (cardiology, palliative care, vascular)	77 (75%)	1 (50%)	29 (76%)	1 (50%)	16 (80%)	4 (80%)	2 (67%)	18 (72%)	6 (75%)

Framework: *National Acute Stroke Services Framework 2019*
ED: emergency department; CT: computed tomography; 24/7: 24 hours a day, 7 days a week;
HDU: high dependency unit; ICU: intensive care unit; TIA: transient ischaemic attack
*Recommended for comprehensive stroke centres only. As such, the denominator will vary, so % is not calculated

3.4 Adherence to aspects of the Framework

Rapid transfer, assessment, and investigations

Hospital-based acute stroke services need to provide rapid assessment supported by streamlined communication with pre-hospital services and the emergency department (ED) to ensure diagnostic investigations, such as brain imaging, are undertaken with minimal time delays.

The pre-hospital communication and clinical processes are designed to ensure prompt transfer to stroke services that have the resources to deliver appropriate care and ensure swift diagnosis and intervention. In this hyperacute phase of care, organised pre-hospital services and coordinated regional stroke systems are essential to support appropriate patient transfer, if required, and/or provide best-practice stroke management.

A larger proportion of services in major cities and inner regional areas had access to pre-notification and pre-hospital services compared with outer regional services (69%). Services in major cities and inner regional areas were noted to have greater access to computerised tomography (CT) brain scan compared with outer regional services (50%) (Table 6).

Table 6. Adherence to recommended pre-hospital and emergency services, by region

	Australia (N=115)	Major Cities (N=62)	Inner Regional (N=37)	Outer Regional^ (N=16)
Receive pre-notification and prepare to rapidly accept potential stroke patient from pre-hospital services	93 (81%)	52 (84%)	30 (81%)	11 (69%)
Coordinated ED systems (includes use of validated screening tools; agreed triage categories; rapid imaging; rapid referral and involvement of stroke team; protocols for intravenous thrombolysis and endovascular thrombectomy intervention or transfer)	93 (81%)	53 (85%)	28 (76%)	12 (75%)
On-site CT brain (24/7) including CT angiography and aortic arch to cerebral vertex angiography	88 (77%)	52 (84%)	28 (76%)	8 (50%)

^Outer Regional classification includes one remote stroke service
ED: emergency department; CT: computerised tomography; 24/7: 24 hours a day, 7 days a week

Support for all services that admit <75 patients with acute stroke each year is needed, as they have reported limited resources for recommended pre-hospital and emergency protocols (Table 7). Further analysis shows 19 out of these 21 services with <75 annual admissions (95%), reported providing rapid brain imaging (e.g., with the first 30 minutes), however only seven (33%) had on-site CT brain scan (24/7) including CT angiography.

Only five services with low annual stroke admissions (<75 annual admissions) reported having an agreement in place with the local ambulance service to bypass the service for another hospital with stroke specific services. Overall, 15 sites reported arrangements with the local ambulance service for emergency/rapid transfer to their service for patients with acute stroke, over and above the regular system (pre-notification, rapid imaging, agreed triage protocols, etc.). Of concern one of these services had no arrangement in place with local ambulance service for pre-notification and/or agreement to bypass our hospital for another stroke specific service, as appropriate.

Table 7. Adherence to recommended pre-hospital and emergency services, by annual stroke admissions

	Reported annual stroke admissions				
	<75 (N=21)	75-199 (N=29)	200-349 (N=27)	350-499 (N=18)	500+ (N=20)
Receive pre-notification and prepare to rapidly accept potential stroke patient from pre-hospital services	12 (57%)	18 (62%)	26 (96%)	17 (94%)	20 (100%)
Coordinated ED systems (includes use of validated screening tools; agreed triage categories; rapid imaging; rapid referral and involvement of stroke team; protocols for intravenous thrombolysis and endovascular thrombectomy intervention or transfer)	11 (52%)	20 (69%)	24 (89%)	18 (100%)	20 (100%)
On-site CT brain (24/7) including CT angiography and aortic arch to cerebral vertex angiography	7 (33%)	22 (76%)	22 (81%)	18 (100%)	19 (95%)

ED: emergency department; CT: computerised tomography; 24/7: 24 hours a day, 7 days a week

Reperfusion services

Acute stroke services should provide access (on-site or by transfer) to recommended reperfusion therapy, including thrombolysis and endovascular thrombectomy for people experiencing ischaemic stroke. Reperfusion therapies are time dependent and should be provided rapidly (e.g., within hours after stroke onset). Prompt treatment with clot-dissolving (thrombolytic) drugs can restore blood flow before major brain damage has occurred and assist people to make a good recovery from their stroke (Table 8).

Endovascular thrombectomy is a highly effective treatment with evidence of benefit in selected patients with large vessel occlusion.[9] Treatment may occur either following thrombolysis or as initial treatment in patient's ineligible for thrombolysis. Given that this treatment is only appropriate to provide in CSCs, system-wide transfer and management policies are needed to ensure efficient pathways between hospitals and ambulance services.

Table 8. Adherence to the Framework recommended reperfusion services, by annual stroke admissions

	Australia (N=115)	Reported annual stroke admissions				
		<75 (N=21)	75-199 (N=29)	200-349 (N=27)	350-499 (N=18)	500+ (N=20)
Delivery of thrombolysis	101 (88%)	12 (57%)	24 (83%)	27 (100%)	18 (100%)	20 (100%)
On-site endovascular thrombectomy (24/7)	15 (13%)	0 (0%)	0 (0%)	0 (0%)	5 (28%)	10 (50%)

24/7: 24 hours a day, 7 days a week

One hundred and one services (88%) reported offering thrombolysis and 92 of these services provided the service 24/7. These services reported thrombolysing 2705 patients with stroke in the previous 12 months (Table 9).

Twenty-six services who deliver thrombolysis, reported thrombolysing fewer than 8 patients in the past 12 months. This includes four services that reported having capacity to perform thrombolysis services but did not thrombolyse any patients in the last 12 months.

Table 9. Annual thrombolysis numbers, by region and setting

	Australia (N=101)	Region^			Setting	
		Major Cities (N=54)	Inner Regional (N=34)	Outer Regional (N=13)	Public (N=97)	Private (N=4)
Median (Q1, Q3) number of patients receiving thrombolysis per service in 2020	**16 (6, 38)**	35 (10, 61)	11 (5, 18)	6 (3, 12)	18 (6, 44)	9 (7, 13)
Total number of patients receiving thrombolysis in 2020	**2705**	2151	426	128	2667	38

^Outer Regional classification includes one Remote stroke service
Q1: 1st quartile; Q3: 3rd quartile

Time to receiving reperfusion stroke therapies is important for patient outcomes and is discussed with the Clinical Audit results in Chapter 4. It was noted that services with greater numbers of stroke admissions provided more thrombolysis per service (Table 10).

Table 10. Annual thrombolysis numbers, by annual stroke admissions and presence of a stroke unit

	Reported annual stroke admissions					Stroke Unit	
	<75 (N=12)	75-199 (N=24)	200-349 (N=27)	350-499 (N=18)	500+ (N=20)	Yes (N=83)	No (N=18)
Median (Q1, Q3) number of patients receiving thrombolysis per service in 2020	3 (2, 6)	10 (4, 14)	15 (10, 24)	36 (24, 56)	62 (48, 76)	23 (10, 51)	3 (2, 10)
Total number of patients receiving thrombolysis in 2020	48	232	433	706	1286	2599	106

Q1: 1st quartile; Q3: 3rd quartile

The largest, overall number of thrombolysed patients was in NSW, which also has the largest population density relative to other jurisdictions (Table 11).

Table 11. Annual thrombolysis numbers, by location

	ACT (N=2)	NSW (N=30)	NT (N=2)	QLD (N=24)	SA (N=6)	TAS (N=3)	VIC (N=27)	WA (N=7)
Median (Q1, Q3) number of patients receiving thrombolysis per service in 2020	Min 20, Max 54	22 (10, 44)	Min 3, Max 6	11 (3, 24)	21 (5, 54)	13 (12, 21)	20 (10, 61)	10 (6, 30)
Total number of patients receiving thrombolysis in 2020	74	891	9	508	255	46	793	129

Q1: 1st quartile; Q3: 3rd quartile; Min; minimum; Max: maximum

Twenty services (17%) reported providing endovascular thrombectomy to 2194 patients (Table 12) in the 2021 organisational survey (up from 1904 reported in 2019). These services were reported only in major cities and limited to services that admit more than 350 patients with stroke in the past 12 months.
The Framework recommends endovascular thrombectomy services be available 24/7 to be classified as a CSC. Five of these services did not provide 24/7 access, therefore not classified as a CSC, and three of which admit over 500 patients with stroke annually.
Arrangements with other states is in place to support Tasmania and the Northern Territory where an endovascular thrombectomy service is currently unavailable. For example, the Victorian Stroke Telemedicine program supports transfer of Tasmanian patients to a service in Melbourne, VIC.

Table 12. Access to on-site endovascular thrombectomy services, by location

|	Australia (N=115)	ACT (N=2)	NSW (N=38)	QLD (N=25)	SA (N=6)	TAS (N=3)	VIC (N=28)	WA (N=11)
Services with on-site endovascular thrombectomy services	20 (17%)	1 (50%)	6 (16%)	3 (12%)	1 (17%)	1 (33%)	5 (18%)	3 (27%)
Endovascular thrombectomy services with 24/7 access^#	15	1	4	3	1	1	4	1
Percentage of these services that have 24/7 access to endovascular thrombectomy	75%	100%	67%	100%	100%	100%	80%	33%
Total number of patients receiving endovascular thrombectomy in 2020	2194	59	641	340	240	0	602	312

24/7: 24 hours a day, 7 days a week
^Recommended for comprehensive stroke centres only
#Denominator will vary from state to state so % is not calculated

Use of reperfusion treatments, including thrombolysis and/or endovascular thrombectomy, has increased across Australia, providing an indicative total of 4899 reported in the 2021 organisational survey (~7% increase from 4555 reported in 2019). Endovascular thrombectomy interventions have increased by 15% in Australia (1904 in 2019 to 2194 in 2021). The total of both types of reperfusion treatments performed by each state is shown in Figure 3.

Figure 3. Total number of annual reperfusion treatments by state
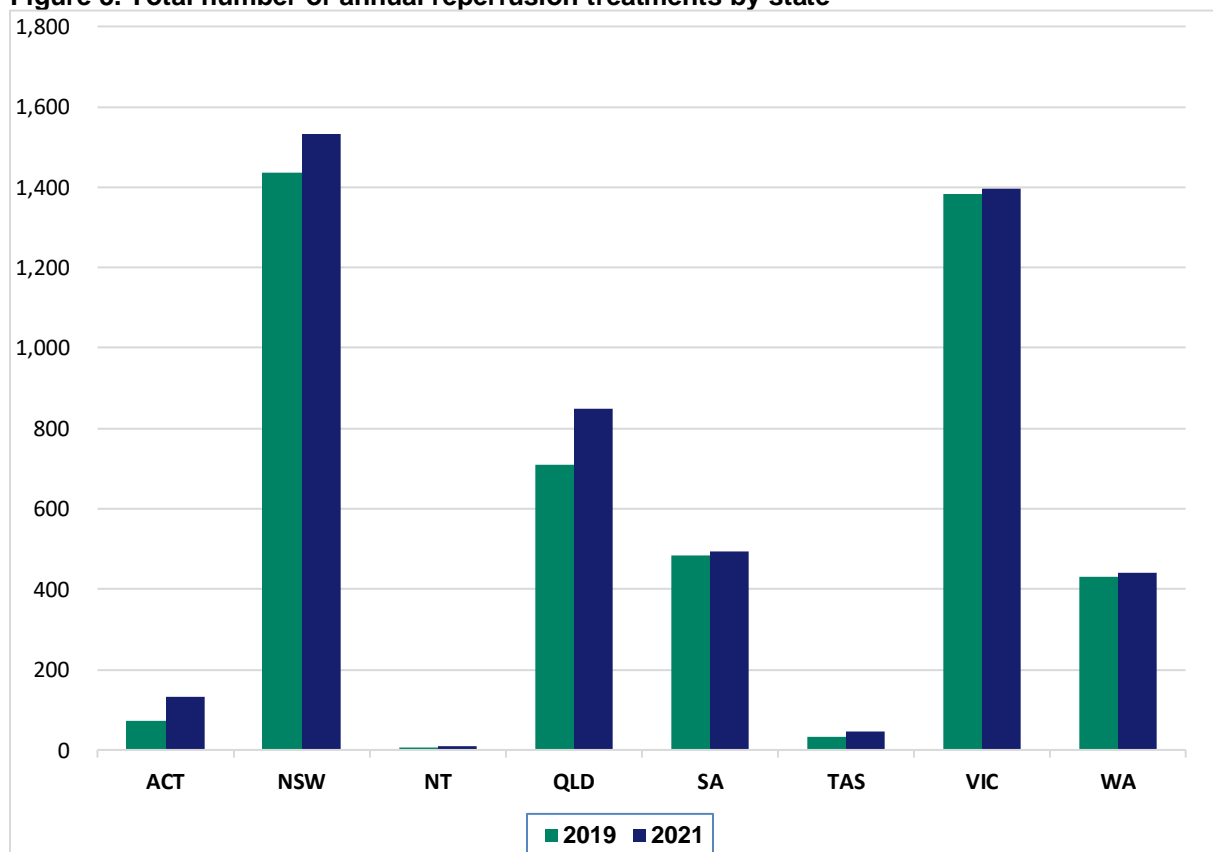
NB. Some patients receive both thrombolysis and endovascular thrombectomy treatments.

ACT and SA have the highest per capita rates of endovascular thrombectomy as related to the overall state population (13 endovascular thrombectomy procedures per 100,000 population) and WA (12 per 100,000) and then VIC (9 per 100,000); with the national average 8.5/100,000. NSW and QLD were below national average at 8 per 100,000 (NSW) and 6.5 per 100,000 (QLD) respectively.

Telehealth and regional responsibility

Services may also have links to regional or 'spoke' services (in a hub and spoke referral system) to support acute clinical care and provide education to non-specialist staff (Table 13). There were 67 services (58%) reporting they had regional responsibility for specialist stroke care and offering support to smaller services. However, medical leads were absent in nine of the services providing regional support. Two of these services did not have a stroke care coordinator and six services reporting regional responsibility did not report having access to a stroke unit.

Table 13. Access to Telehealth and regional responsibility, by region

	Australia (N=115)	Region^		
		Major Cities (N=62)	Inner Regional (N=37)	Outer Regional (N=16)
Regional responsibility (e.g., coordination across local health district)	67 (58%)	35 (56%)	23 (62%)	9 (56%)
Use of Telehealth services for acute assessment and treatment	87 (76%)	38 (61%)	33 (89%)	16 (100%)
If yes, is Telehealth usually used to provide support to another service	31 (36%)	25 (66%)	3 (9%)	3 (19%)

^Outer Regional classification includes one Remote stroke service

Telehealth for acute stroke usually takes the form of video-teleconferencing, via telephone or internet, to support acute stroke intervention. However, consults with a telephone call and diagnosis through remote imaging are also included as telemedicine. There has been a small increase in the number of services using Telehealth (87 in 2021 from 86 services in 2019) coinciding with an increase in specialisation with the number of sites providing support reducing (down to 31 from 34 services in 2019), therefore the system may be becoming more centralised.

Stroke unit care

The Framework recommends that all patients with suspected stroke should be transported to a hospital with a stroke unit. Organisation of acute stroke services with dedicated personnel and processes is fundamental to maximising patient outcomes and is explored further in the clinical audit results section of this report.

Stroke units are not recommended for small services, where stroke numbers are insufficient to justify dedicated resources. Instead, these smaller hospital services should have appropriate systems in place to rapidly screen and then transfer patients with stroke to the nearest dedicated stroke service, where feasible.

A stroke unit differs from other wards. Stroke units that have been shown to deliver highly effective stroke care share several characteristics,[6] including:

- Location in a geographically discrete unit
- Comprehensive assessments
- A coordinated multidisciplinary team, consists of medical, nursing, and allied health professionals, including occupational therapy, physiotherapy, speech pathology, social work, and dietetics.
- Early mobilisation and avoidance of bedrest
- Staff with a special interest in the management of stroke, and access to ongoing professional education and training
- Clear communication, with regular team meetings to discuss management (including discharge planning) and other meetings as needed (e.g., family conferences)
- Active encouragement of stroke survivors and their carers/families to be involved in the rehabilitation process.

Ninety-three services (81%) reported having a stroke unit, with 766 dedicated acute stroke beds (median 6 beds per unit [Q1 4, Q3 10]). These 93 services admitted a total of 33,728 patients with acute stroke in 2020 and 25,375 patients in these services were admitted to their stroke unit (or 75% of the total number reported in the Organisational Survey). Despite the Framework recommending that all services admitting ≥75 strokes annually should have a dedicated stroke unit, 10 of these larger services reported NOT having a stroke unit.

Stroke unit capacity at a single point in time was established by analysing the number of patients with stroke in a service on the day the Organisational Survey was completed, compared with the number of dedicated stroke unit beds in all services and in stroke unit services (Table 14). The analysis showed there was wide variability in the availability of dedicated stroke unit beds to manage patients with stroke.

On the day of completion of the Organisational Survey, 725 patients with acute stroke were present in services with a stroke unit. Among these patients, 515 patients (71%) were being cared for in a dedicated acute stroke unit bed. However, 210 patients (29%) in these services were not in a stroke unit bed, despite the availability of 254 stroke unit beds (i.e., bed occupied by non-stroke patients). This suggests that bed management systems be reviewed so that hospitals can prioritise the movement patients into stroke unit beds.

Table 14. Stroke Unit Access, stroke service experience on the day the organisational survey was completed

	Total services	Patients with acute stroke in all services	Dedicated stroke unit beds per service. Total: median (Q1, Q3)	Services with a stroke unit	Patients with acute stroke in a service with stroke unit	Patients in stroke unit bed on day of audit
Australia	**115**	**783**	**766: 6 (4, 10)**	**93**	**725**	**515**
ACT	**2**	22	8: Min 4, Max 4	2	22	6
NSW	**38**	282	265: 5 (4, 8)	37	273	183
NT	**2**	9	4	1	6	3
QLD	**25**	128	149: 6 (5, 12)	19	123	97
SA	**6**	53	67: 16 (9, 25)	4	49	46
TAS	**3**	23	19: Min 8, Max 11	2	17	15
VIC	**28**	181	190: 4 (4, 10)	22	170	120
WA	**11**	85	64: 12 (6, 12)	6	65	45
Reported annual stroke admissions						
<75	**21**	28	36: 4 (4, 4)	9	14	10
75-199	**29**	111	101: 4 (4, 5)	22	83	61
200-349	**27**	143	171: 5 (4, 9)	24	127	100
350-499	**18**	180	176: 8 (6, 10)	18	180	116
500+	**20**	321	282: 12 (8, 18)	20	321	228

Q1: 1st quartile; Q3: 3rd quartile; Min: minimum; Max: maximum

Acute stroke team

The Framework specifies that the minimum criterion for acute stroke care is a "*dedicated, interprofessional team with members who have a special interest in stroke and/or rehabilitation*".[3] The team consists of medical, nursing, and allied health professionals, including occupational therapy, physiotherapy, speech pathology, social work, and dietetics. It is recommended that all primary and comprehensive services have a stroke care coordinator (SCC) to facilitate integrated care across the patient journey.

A SCC is defined as overseeing the clinical organisation for stroke services or providing support for ensuring the quality of stroke care delivered at the service. Stroke care coordinators were reported to be working at 80 services (70%). In the services with a stroke unit, 71 out of 93 (76%) reported an SCC on staff. Among the 22 services without a stroke unit, where coordinated care may be even more important, this role was reported in only 9 stroke services.

Ninety-one services (79%) reported that a consultant physician with specialist knowledge of stroke was formally recognised as having principal responsibility for stroke management at their service (Table 15). However, of the services with a stroke unit, nine services reported not having a dedicated stroke medical lead. In this latter situation, seven of those services reported an SCC and two services reported no specialist medical or stroke care coordinator.

Table 15. Acute stroke team, by location and stroke annual stroke admissions

	Stroke specialist medical lead	Stroke care coordinator	Multidisciplinary stroke team*
Australia (N=115)	**91 (79%)**	**80 (70%)**	**106 (92%)**
ACT (N=2)	2 (100%)	2 (100%)	2 (100%)
NSW (N=38)	31 (82%)	28 (74%)	37 (97%)
NT (N=2)	2 (100%)	1 (50%)	1 (50%)
QLD (N=25)	18 (72%)	13 (52%)	23 (92%)
SA (N=6)	4 (67%)	3 (50%)	6 (100%)
TAS (N=3)	2 (67%)	1 (33%)	2 (67%)
VIC (N=28)	24 (86%)	23 (82%)	26 (93%)
WA (N=11)	8 (73%)	9 (82%)	9 (82%)
Reported annual stroke admissions			
<75 (N=21)	11 (52%)	11 (52%)	16 (76%)
75–199 (N=29)	20 (69%)	20 (69%)	27 (93%)
200–349 (N=27)	22 (81%)	18 (67%)	25 (93%)
350–499 (N=18)	18 (100%)	14 (78%)	18 (100%)
500+ (N=20)	20 (100%)	17 (85%)	20 (100%)

*Multidisciplinary team consists of medical, nursing and allied health professionals, including occupational therapy, physiotherapy, speech pathology, social work and dietetics.

All services with large annual stroke admissions (350+ per annum) reported having a neurologist actively involved in stroke management. Specialist neurologists were less prominent outside major city locations (actively involved with stroke management at 38% of outer regional services and 32% of inner regional services, compared with 85% of services in major cities).

Seventeen of the 20 services (85%) with 500+ annual stroke admissions reported that an SCC was actively involved with stroke management. However, only 52% of services with <75 stroke annual admissions had a designated SCC on staff. Of the 35 services without an SCC, 25 (65%) reported having a specialist nurse role. The involvement of specialist nurses in the management of stroke across Australia is shown in Table 16. Further work is needed to understand the different nursing roles related to ensuring coordinated and specialised stroke care as they can vary from state to state.

Table 16. Specialist nurses actively involved in the management of stroke, by location

	Australia (N=115)	ACT (N=2)	NSW (N=38)	NT (N=2)	QLD (N=25)	SA (N=6)	TAS (N=3)	VIC (N=28)	WA (N=11)
Clinical nurse consultant (CNC)	46 (40%)	1 (50%)	14 (37%)	1 (50%)	12 (48%)	4 (67%)	3 (100%)	9 (32%)	2 (18%)
Clinical nurse specialist (CNS)	54 (47%)	2 (100%)	21 (55%)	1 (50%)	3 (12%)	1 (17%)	0 (0%)	18 (64%)	8 (73%)
Nurse practitioner	15 (13%)	1 (50%)	3 (8%)	2 (100%)	3 (12%)	0 (0%)	0 (0%)	4 (14%)	2 (18%)

Clinical psychologists and neuropsychologists were actively involved in the management of patients with stroke at approximately a third of services (Table 17). Most of the psychology professionals were based in major cities (48% clinical psychologists, 50% neuropsychologists) and often employed together. There was lower representation in regional areas (inner regional: 19% clinical psychologists, 11% neuropsychologists; outer regional: 13% clinical psychologists and neuropsychologists) and 64 services had neither neuro- nor clinical psychology staff on-site.

Table 17. Allied Health professionals actively involved in the management of stroke, by location

	Australia (N=115)	ACT (N=2)	NSW (N=38)	NT (N=2)	QLD (N=25)	SA (N=6)	TAS (N=3)	VIC (N=28)	WA (N=11)
Clinical psychologist	**39 (34%)**	1 (50%)	8 (21%)	0 (0%)	13 (52%)	3 (50%)	0 (0%)	10 (36%)	4 (36%)
Neuropsychologist	**37 (32%)**	1 (50%)	14 (37%)	0 (0%)	7 (28%)	1 (17%)	1 (33%)	10 (36%)	3 (27%)
Dietitian	**113 (98%)**	2 (100%)	37 (97%)	2 (100%)	24 (96%)	6 (100%)	3 (100%)	28 (100%)	11 (100%)
Occupational therapist	**114 (99%)**	2 (100%)	38 (100%)	2 (100%)	24 (96%)	6 (100%)	3 (100%)	28 (100%)	11 (100%)
Physiotherapist	**114 (99%)**	2 (100%)	38 (100%)	2 (100%)	24 (96%)	6 (100%)	3 (100%)	28 (100%)	11 (100%)
Social worker	**113 (98%)**	2 (100%)	38 (100%)	2 (100%)	23 (92%)	6 (100%)	3 (100%)	28 (100%)	11 (100%)
Speech pathologist	**114 (99%)**	2 (100%)	38 (100%)	2 (100%)	24 (96%)	6 (100%)	3 (100%)	28 (100%)	11 (100%)

Team communication and protocols

Regular communication among the interdisciplinary team is vital to address key issues that may arise during a patient's hospital admission in a timely manner. The Framework specifies that the "interprofessional team meet at least once per week to discuss patient care".[3]

Regular team meetings (case conferences) occurred at 107 services (93%). Of these, the median frequency of meetings was eight per month, or twice per week (with 32 services meeting daily or 20 times per month).

The routine use of guidelines, care plans and protocols were in greater use at services with stroke units (75%) than services without a stroke unit (36%). Overall, 102 services (89%) reported having a clinical care pathway in place for managing stroke. Protocols for referral to speech pathology (99%), physiotherapy (98%), occupational therapy, social work, and dietetics (97%) were almost universal. Psychology referral protocols were reported at only 52% of services.

Rehabilitation

Acute services must coordinate with rehabilitation services to facilitate seamless transfer of care for people with stroke. Rehabilitation is a holistic process that should begin the first day after stroke, with the aim of maximising the participation of the person with stroke in the community.[9] Adherence to recommended rehabilitation practices is shown in Table 18.

Table 18. Adherence to recommended rehabilitation practices, by annual stroke admissions

	Australia (N=115)	Reported annual stroke admissions				
		<75 (N=21)	75–199 (N=29)	200–349 (N=27)	350–499 (N=18)	500+ (N=20)
Coordination with rehabilitation service providers	106 (92%)	16 (76%)	27 (93%)	25 (93%)	18 (100%)	20 (100%)
Standardised processes that ensure ALL stroke patients are assessed for rehabilitation	94 (82%)	12 (57%)	25 (86%)	21 (78%)	17 (94%)	19 (95%)
Routine involvement of patients and carers in the rehabilitation process	115 (100%)	21 (100%)	29 (100%)	27 (100%)	18 (100%)	20 (100%)

Eighty-eight services (77%) reported having a rehabilitation physician actively involved in patient management. More services in major cities reported involvement of a rehabilitation physician (87%) compared with inner (68%) and outer (56%) regional services, as did services with a stroke unit (84%) compared with services without a stroke unit (45%).

Regarding assessing suitability for rehabilitation, most services (97%) reported that the acute interdisciplinary team were responsible for making the referral to rehabilitation, followed by the acute physician (84%) and then a joint decision from both the acute and rehabilitation team members (77%). Overall, 94 services (82%) reported a standardised process regarding assessing suitability for further rehabilitation at their service.

One hundred and six services (92%) reported having access to ongoing inpatient rehabilitation, 102 services (89%) reported having access to outpatient rehabilitation, and 96 services (83%) reported the ability to access community-based rehabilitation provided in the home. Very few services reported access to day hospital rehabilitation (32%) or stroke specialist Early Supported Discharge (15%).

Access to other specialist services
Access and collaboration with specialist services (cardiology, palliative, and vascular surgery) were routinely (100%) reported in services with higher annual stroke admissions (350-499 and 500+ admissions) (Table 19). Among those services admitting <75 strokes per year, only 29% had access to specialist services. Neurosurgical services were also more common in higher annual stroke admissions services (70% if admitting 500+ annual stroke admissions, versus 5-7% if <200 annual stroke admissions).

Table 19. Adherence to recommended rehabilitation practices, by annual stroke admissions

	Australia (N=115)	Reported annual stroke admissions				
		<75 (N=21)	75–199 (N=29)	200–349 (N=27)	350–499 (N=18)	500+ (N=20)
Access and collaboration with other specialist services (cardiology, palliative care, vascular)	81 (70%)	6 (29%)	19 (66%)	18 (67%)	18 (100%)	20 (100%)

Quality improvement activities and ongoing professional development
Embedding a culture of evidence-based practice can be facilitated by targeted education and collaborative involvement in data collection for guiding quality improvement efforts. The Framework specifies that there be access to "regular programs of staff education and training relating to stroke (e.g., dedicated stroke in-service program and/or access to annual national or regional stroke conferences)".[3]

A total of 103 services (90%) reported having access to a program of continuing education for stroke management staff. Staff in major cities and larger services were more likely to have opportunities for professional development (98% in major cities versus 86% in inner regional and 63% in outer regional services; 100% in 350+ stroke admission services versus 62% for <75 stroke admissions). Also, staff in a stroke unit 100% compared to staff in a service that does not have a stroke unit (64%).

Services for patients with transient ischaemic attack (TIA)

Hospitals should also have systems for rapid assessment and management of people with suspected TIA to prevent stroke. Diagnostic work-up and implementation of optimal therapy for patients with suspected TIA should be completed within 48 hours.[9] It is highly recommended that all services develop a local TIA pathway involving primary care, ED, and stroke specialist teams to ensure patients are managed as rapidly and comprehensively as possible, matching locally available resources.[9]

Ninety-nine services (86%) reported having a defined and documented process, policy or clinical pathway for assessing TIA patients (Table 20). Thirty-four services (30%) reported admitting all TIA patients, while 81 services (70%) reported admitting only select TIA patients. Of these, 41 services (51%) reported having a rapid access TIA clinic for TIA patients not admitted.

Table 20. Adherence to recommended TIA services, by annual stroke admission

	Australia (N=115)	Reported annual stroke admissions				
		<75 (N=21)	75–199 (N=29)	200–349 (N=27)	350–499 (N=18)	500+ (N=20)
Does your hospital have a defined and documented process, policy or clinical pathway for assessing TIA patients?	99 (86%)	17 (81%)	24 (83%)	24 (89%)	15 (83%)	19 (95%)
Rapid (within 48 hours) TIA assessment clinics/services (including early access to carotid and advanced brain imaging)	58 (50%)	9 (43%)	12 (41%)	14 (52%)	8 (44%)	15 (75%)

TIA: transient ischaemic attack

However, while the recommendation is for assessment within 48 hours, the median waiting time for an appointment at a TIA clinic is 5 days (Q1:2 days, Q3:10 days). Access to rapid assessment clinics or management services for patients with TIA is more common in services with 500+ reported annual stroke admissions (75%).

Chapter 4: Clinical Audit Results

The *Acute Stroke Clinical Care Standard* (2019)[2] outlines 16 suggested process indicators covering seven quality statements for stroke care. While many are based on existing national performance indicators for stroke, this report provides data for all indicators except assessment by ambulance services.

Key findings:

- Incremental improvements in 14 out of 16 clinical indicators (Figure 4) across Australia even with the backdrop of COVID-19 last year, with statistically significant improvements in nine indicators.
- Nationwide decrease in the quality of hyperacute care with thrombolysis within 60 minutes of hospital arrival dropping from 32% in 2019 to 27% in 2021.
- The national median time from onset (patient awareness) of stroke symptoms to thrombolysis was 2 hours:50 minutes, a significant decrease from previous audits.
- Regional services with formal acute telehealth support have higher rates metrics related to thrombolysis compared to regional services without telehealth.

4.1 Characteristics of patients in the Clinical Audit

A total of 3890 patient case notes were audited from 104 services. The median age of patients was 75 years, 43% were female, only 4% of patients were identified as being of Aboriginal and/or Torres Strait Islander background, and 6% required an interpreter (Table 21).

Table 21. Patient demographics, by region

Patient demographics	Australia (N=3890)	Major Cities (N=2334)	Inner Regional (N=1131)	Outer Regional ^ (N=425)
Age – median (Q1, Q3)	75 (64, 83)	75 (64, 83)	75 (65, 83)	73 (62, 82)
Sex – female	1673 (43%)	999 (43%)	484 (43%)	190 (45%)
Patient identifying as Aboriginal and/or Torres Strait Islander background	148 (4%)	51 (2%)	37 (3%)	60 (14%)
Patient requiring interpreter	221 (6%)	189 (8%)	10 (1%)	22 (5%)
Stroke type				
Ischaemic stroke	3299 (85%)	1995 (85%)	970 (86%)	334 (79%)
Intracerebral haemorrhage	494 (13%)	297 (13%)	133 (12%)	64 (15%)
Undetermined stroke type	97 (2%)	42 (2%)	28 (2%)	27 (6%)
Pre-stroke information				
Independence prior to admission (mRS 0–2)	3144 (81%)	1906 (82%)	917 (81%)	321 (76%)

^Outer Regional classification includes one Remote stroke service
Q1: 1st quartile, Q3: 3rd quartile
mRS: modified Rankin Scale, TIA: transient ischaemic attack

Eighty-one percent of patients had a modified Rankin Scale (mRS) score of 0–2 prior to their stroke, indicating they had no disabilities or minor disabilities (mRS is a commonly used scale for measuring the degree of disability or dependence in the daily activities of people).

More than half of patients had arm deficits and/or speech/communication impairments on admission to hospital (Table 22).

Table 22. Impairments present on admission

	Australia N=3890
Arm deficit	2148 (57%)
Speech/communication impairment	1974 (52%)
Lower limb deficit	1807 (48%)
Balance	1577 (45%)
Sensory deficit	1203 (33%)
Cognitive deficit	1159 (32%)
Visual deficit	1056 (29%)
Dysphagia	1032 (28%)
Continence	822 (23%)
Perceptual deficit	679 (20%)
Nutrition problems	489 (14%)
Hydration problems	444 (13%)
Other impairment	421 (12%)

*Denominators vary due to exclusion of "Not documented" responses

The six most common impairment/s due to stroke on admission include:
- Arm deficit, difficulty moving any part of the arm specifically due to the stroke e.g., hand, elbow, and/or shoulder.
- Speech/communication impairment, any form of expressive or receptive dysphasia or aphasia, verbal dyspraxia, or dysarthria.
- Lower limb deficit, difficulty moving any part of the leg specifically due to the stroke e.g., foot, knee, or hip.
- Balance, impaired ability in balance either while sitting, standing, or walking.
- Sensory deficit, any impairment of the sensory system.
- Cognitive deficit, any impairment of memory or higher executive functions.

4.2 National Performance on the Acute Stroke Clinical Care Standard 2019 indicators

The ACSQHC provides a set of suggested indicators to assist with local monitoring of the Standard (https://www.safetyandquality.gov.au/our-work/clinical-care-standards/acute-stroke-clinical-care-standard). The standards were updated in 2019, and to align with these changes, six indicators have been removed, four have had a change in the denominator and one new clinical indicator for rehabilitation has been added. More detail regarding these changes and the methods for the audit are outlined in Appendix.

The definitions of the indicators reported (including numerators and denominators, and exclusion criteria) are available in the supplement for this report available at https://informme.org.au/stroke-data.

Further information on national performance in the clinical indicators from 2017 to 2021 is presented in Chapter 5. National adherence to select clinical recommendations outlined in the Standard is represented in Table 23 below.

Table 23. Performance on *Acute Stroke Clinical Care Standard* Indicators, by location

	Australia	ACT	NSW	NT	QLD	SA	TAS	VIC	WA
Validated stroke screen in the emergency department [†]	**69%**	64%	77%	31%	59%	83%	56%	72%	64%
Thrombolysis in patients with ischaemic stroke	**11%**	15%	11%	7%	11%	18%	15%	13%	4%
Thrombolysis within 60 minutes of hospital arrival	**27%**	14%	27%	0%	11%	48%	47%	32%	27%
Median time from stroke onset to thrombolysis (hours:minutes)	**2:50**	3:04	2:41	2:53	3:17	2:35	2:31	2:49	2:51
Admission to a stroke unit	**73%**	94%	82%	41%	76%	78%	54%	66%	60%
90% of acute hospital care on a stroke unit	**47%**	47%	43%	32%	45%	56%	28%	55%	50%
Assessment by a physiotherapist within 24-48 hours of arrival to ED[‡]	**81%**	94%	83%	62%	79%	87%	81%	79%	80%
Assessment for ongoing rehabilitation completed using a structured assessment tool prior to discharge[‡]	**67%**	68%	67%	59%	64%	73%	42%	67%	80%
Patient received education about behaviour change for modifiable risk factors	**78%**	98%	78%	58%	82%	85%	91%	68%	90%
Discharged on antihypertensive medication (all stroke)[*]	**78%**	71%	79%	70%	82%	70%	83%	77%	72%
Discharge on lipid-lowering medications (ischaemic stroke)[*]	**92%**	93%	91%	87%	94%	85%	89%	92%	93%
Discharge on antithrombotic medications (ischaemic stroke)[*]	**99%**	100%	99%	89%	99%	99%	100%	99%	99%
Discharge on oral anticoagulants for atrial fibrillation (ischaemic	**78%**	100%	82%	83%	77%	94%	50%	68%	81%
Carer received support needs assessment[‡]	**65%**	75%	71%	47%	72%	67%	33%	57%	74%
Carer received relevant training[‡]	**64%**	0%	65%	53%	71%	27%	36%	61%	82%
Care plan developed with the team and the patient (or family alone if patient has severe aphasia or cognitive impairments) [‡]	**76%**	94%	84%	40%	74%	67%	29%	74%	68%

[†]Excludes in-hospital stroke, inter-hospital transfer, unconscious patients
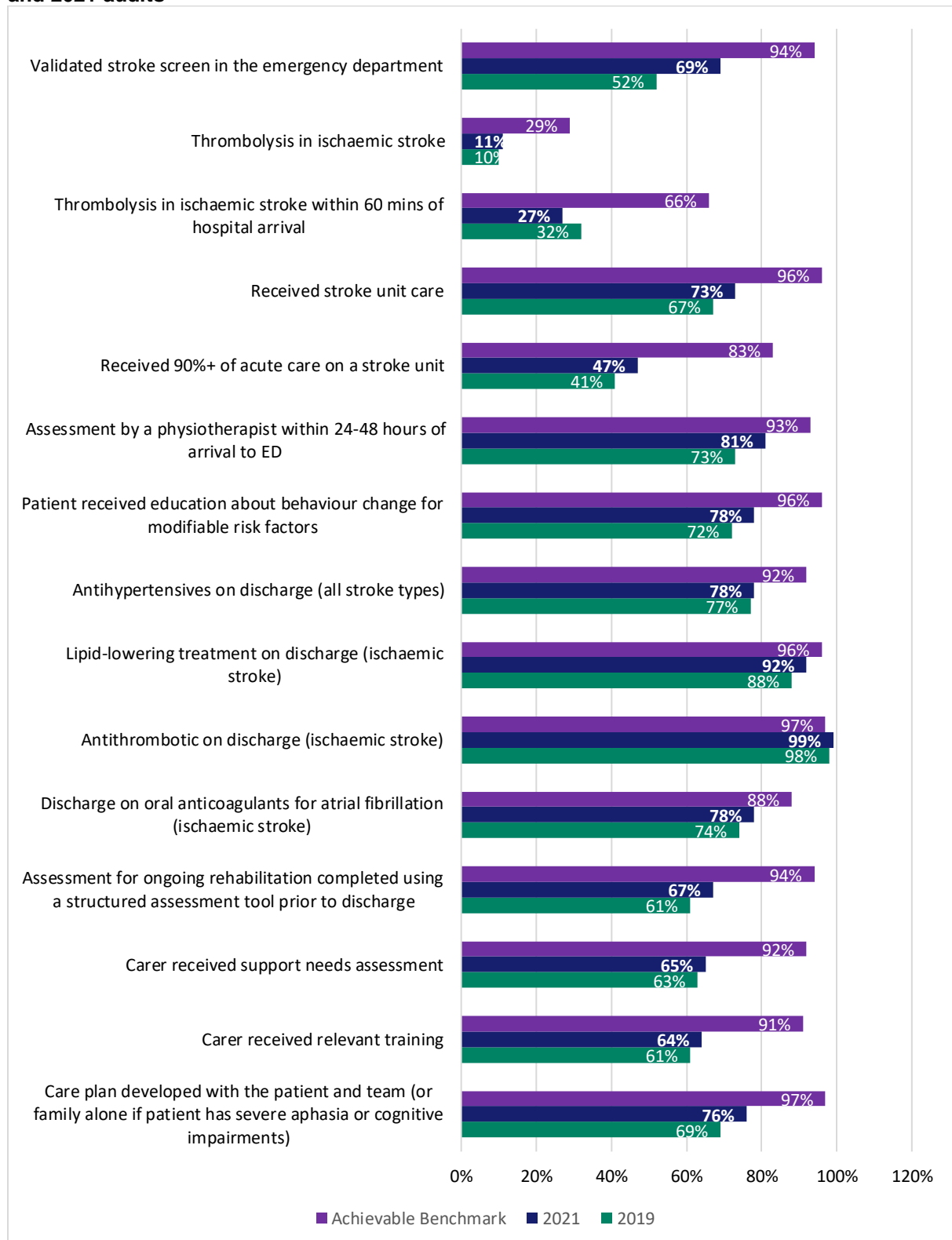ED: Emergency Department
[‡]Excludes patients declining involvement
[*]Excludes those where treatment contraindicated, futile, or refused

National adherence to the indicators in the 2019 and 2021 audit cycles is reported in Figure 4 below (indicator for time from stroke onset to thrombolysis not reported in Figure 4 graphic).

The national benchmarks are based on a modified version of the *Achievable Benchmark of Care* (*ABC*™) methodology[10] (refer to Appendix) whereby these measures represent the results for the top performing services that can be contrasted to the average performance of all services.

Figure 4. National adherence to the *Acute Stroke Clinical Care Standard* Indicators for the 2019 and 2021 audits

Indicator	Achievable Benchmark	2021	2019
Validated stroke screen in the emergency department	94%	69%	52%
Thrombolysis in ischaemic stroke	29%	11%	10%
Thrombolysis in ischaemic stroke within 60 mins of hospital arrival	66%	27%	32%
Received stroke unit care	96%	73%	67%
Received 90%+ of acute care on a stroke unit	83%	47%	41%
Assessment by a physiotherapist within 24-48 hours of arrival to ED	93%	81%	73%
Patient received education about behaviour change for modifiable risk factors	96%	78%	72%
Antihypertensives on discharge (all stroke types)	92%	78%	77%
Lipid-lowering treatment on discharge (ischaemic stroke)	96%	92%	88%
Antithrombotic on discharge (ischaemic stroke)	97%	99%	98%
Discharge on oral anticoagulants for atrial fibrillation (ischaemic stroke)	88%	78%	74%
Assessment for ongoing rehabilitation completed using a structured assessment tool prior to discharge	94%	67%	61%
Carer received support needs assessment	92%	65%	63%
Carer received relevant training	91%	64%	61%
Care plan developed with the patient and team (or family alone if patient has severe aphasia or cognitive impairments)	97%	76%	69%

■ Achievable Benchmark ■ 2021 ■ 2019

†Excludes in-hospital stroke, inter-hospital transfer, unconscious patients
ED: Emergency Department
‡Excludes patients declining involvement
*Excludes those where treatment contraindicated, futile, or refused

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Services with low annual admissions (<75 per year), in outer regional areas, and without a stroke unit were the lowest performing group for almost all indicators. High-volume services (500+ annual stroke admissions), in major cities, with a stroke unit were found to perform better for assessment in validated stroke screen in the ED, thrombolysis indicators and access to stroke unit care.

Similarly, CSCs performed the best for provision of thrombolysis and stroke unit care. There was less variation between CSCs and PSCs in assessment for rehabilitation, physiotherapy assessment, secondary prevention and preparing carers and patients for discharge. Services adhering to more elements outlined in the Framework achieved better performance on the Standard indicators (Table 24).

Table 24. Service performance on indicators, by the Framework adherence and service level

	Framework elements met (% = patient cases)			Service level (% = patient cases)		
	16–20 (N=66 services)	11–15 (N=31 services)	0–10 (N=7 services)	CSC (N=12 services)	PSC (N=86 services)	GH (N=6 services)
Validated stroke screen in the ED	73%	62%	55%	89%	67%	49%
Thrombolysis in patients with ischaemic stroke	12%	9%	10%	16%	11%	7%
Thrombolysis within 60 minutes of hospital arrival	31%	11%	29%	37%	25%	0%
Median time from onset to thrombolysis (hours:minutes)	2:45	3:14	3:03	2:37	2:54	2:55
Admission to a stroke unit	84%	54%	27%	83%	75%	0%
90% of acute hospital care on a stroke unit	55%	32%	12%	57%	47%	0%
Assessment by a physiotherapist within 24-48 hours of arrival to ED	82%	80%	63%	85%	81%	50%
Patient received education about behaviour change for modifiable risk factors	79%	80%	60%	75%	79%	64%
Antihypertensives on discharge (all stroke types)	77%	80%	75%	72%	78%	75%
Lipid-lowering treatment on discharge (ischaemic stroke)	92%	92%	80%	90%	93%	73%
Antithrombotic on discharge (ischaemic stroke)	99%	99%	98%	100%	99%	97%
Discharge on oral anticoagulants for atrial fibrillation (ischaemic stroke)	81%	73%	62%	83%	78%	60%
Carer received support needs assessment	68%	64%	35%	43%	70%	31%
Carer received relevant training	66%	61%	41%	50%	67%	41%
Assessment for ongoing rehabilitation completed using a structured assessment tool prior to discharge	69%	66%	40%	57%	70%	36%
Care plan developed with the patient and team	81%	71%	36%	85%	75%	61%

Framework: *National Acute Stroke Services Framework 2019*
CSC=comprehensive stroke centre; PSC=primary stroke centre; GH=general hospital
[†]Excludes in-hospital stroke, inter-hospital transfer, unconscious patients
[‡]Excludes patients declining involvement
[*]Excludes those contraindicated to treatment, futile, or refused

4.3 Adherence to specific aspects of the Acute Stroke Clinical Care Standard indicators

Time-critical therapy

Access to appropriate screening, assessment, imaging, investigation, and treatment is essential for positive patient outcomes. This is especially the case for thrombolysis, which reduces overall disability and improves functional outcomes when administered as early as possible after onset of ischaemic stroke but is limited by a narrow therapeutic time window and important contraindications.[11]

Most patients with stroke arrived at hospital by ambulance (76%). Ambulance transport with hospital prenotification is preferred as it initiates code stroke protocols in EDs where preparations can be made for early intervention for time dependent care. The median time from stroke onset to arrival in the ED was 4 hours:18 minutes. Thirty percent of patients arrived at hospital within 3 hours, and 37% arrived within 4 hours:30 minutes of stroke symptom onset.

Ninety-nine percent of patients received a brain scan following their stroke, with 45% of scans performed within one hour of arrival to hospital, and 94% performed within 24 hours of arrival to hospital. The majority (73%) of the brain scans were CT scans and the median time of brain scan from arrival to ED was 64 minutes.

Overall, 63% of all patients who presented to hospital were screened for thrombolysis eligibility and 11% of all patients with ischaemic stroke received thrombolysis. Of all ischaemic patients who received thrombolysis, 27% commenced the procedure within 60 minutes of hospital arrival. The national median time from onset of stroke symptoms to thrombolysis was 2 hours:50 minutes (Q1: 2:15; Q3: 3:45).

For those thrombolysed, the median time from arrival at hospital to brain scan (door to scan) was 23 minutes (Q1:13; Q3:45 minutes), and the median time from arrival at hospital to receiving thrombolysis (door-to-needle time) was 78 minutes (Q1 57; Q3: 1:50).

There appears to be greater performance related to time-critical therapy with adherence to Framework elements (especially CSCs) and in those services with more annual stroke admissions. Furthermore, access to appropriate stroke therapies and the provision of thrombolysis treatment was greater in major cities than regional areas (Table 25).

Table 25. Early access and thrombolysis indicators, by region

	Australia (N=3890)	Major Cities (N=2334)	Inner Regional (N=1131)	Outer Regional^ (N=425)
Validated stroke screen in the emergency department	69%	71%	71%	52%
Thrombolysis in ischaemic stroke	11%	13%	11%	6%
Thrombolysis in ischaemic stroke within 60 mins of hospital arrival	27%	29%	24%	15%
Median time from onset to thrombolysis (hours:minutes)	2:50	2:47	3:03	2:45

^Outer Regional classification includes one Remote stroke service

A sub-analysis was undertaken on a small number of regional services to provide insight into the use of telehealth support. Regional services where formal acute telehealth support is used for assistance with clinical decision-making (25 services: 860 patient cases) were compared to regional services without access to telehealth services (13 services: 412 patient cases). These regional services without access to telehealth support also had no on-site neurologist.

The analysis found the use of thrombolysis was greater in regional services with telehealth access (telehealth 11% vs 8%). More patients also received thrombolysis within 60 minutes of hospital arrival at telehealth supported services (telehealth 25% vs no telehealth 9%). The median door-to-needle time was over 30 minutes shorter (telehealth 74 mins; Q1:Q3, 60-105 mins vs 107 mins; Q1:Q3, 87-137 mins), and median stroke onset to treatment time was an hour shorter with telehealth support (telehealth 2 hrs 48 mins vs 3 hrs 47 mins).

Stroke unit care

The organisation of hospital services to provide stroke unit care is the single most important recommendation for improving stroke management.[9] The benefit of patient access to a stroke unit is shown in the tables following, which supports the configuration of services to ensure patients with stroke receive interdisciplinary care in a stroke unit.

Sixty percent of patients were admitted directly to a stroke unit on arrival at hospital, with 25% of patients admitted to a medical ward on admission, and 7% of patients admitted directly to ICU/HDU. The median time from hospital arrival to admission to a stroke unit was 6 hours:42 minutes (in contrast to 7 hours:36 minutes in the 2019 audit). Of all patients in the clinical file review component of the audit, 73% received care during their acute admission in a stroke unit, and only 47% of these patients spent at least 90% of their acute hospital stay in a stroke unit. Access to stroke unit care varied considerably across location (Table 26).

Table 26. Stroke Unit care indictors, by region

	Australia (N=3890)	Major Cities (N=2334)	Inner Regional (N=1131)	Outer Regional^ (N=425)
Received stroke unit care	73%	84%	64%	41%
Received 90%+ of acute care in a stroke unit	47%	53%	41%	28%

^Outer Regional classification includes one Remote stroke service

All acute stroke services should implement standardised protocols to manage fever, glucose and swallowing difficulties in patients with stroke.[9,12] Early recognition and management of fever and raised glucose occurred in less than 30% of patients, with similarities at services with and without a stroke unit (Table 27).

More patients treated on a stroke unit received swallow screening or assessment and were screened within 24 hours of admission and either screened or assessed before being given oral intake, which included medication, food, or fluids, than patients not treated on a stroke unit.

Recent evidence incorporated into the clinical guidelines for stroke management recommends patients receive a swallow screen within four hours of admission. Although there has been some improvement over the last three audit cycles (19% in 2017 to 30% in 2021), swallow screen within four hours has still only occurred for one in four patients with median time 5 hours:6 minutes.

Table 27. Fever, glucose, and swallow process, by stroke unit access

	Australia (N=3890)	Treated in a stroke unit (N=2844)	Not treated in a stroke unit (N=1046)
Fever			
Patient developed fever ≥ 37.5°C within first 72 hours	10%	10%	9%
Paracetamol for the first elevated temperature administered within 1 hour*	50%	49%	51%
Glucose			
Hyperglycaemia (first 48 hours of admission)	19%	19%	18%
Insulin administered within 1 hour of the first elevated finger-prick glucose (>=10 mmol/L)	29%	27%	34%

	Australia (N=3890)	Treated in a stroke unit (N=2844)	Not treated in a stroke unit (N=1046)
Swallow			
Formal swallow screen performed	**64%**	71%	46%
Swallow screen within 24 hours	**58%**	65%	40%
Swallow screen within 4 hours of admission	**27%**	30%	20%
Swallow assessment by speech pathologist	**74%**	78%	63%
Swallow screen or assessment performed	**88%**	93%	72%
Swallow screen or assessment performed before given oral intake (medications, food or fluids)	**60%**	66%	43%

*Excludes those already receiving regular paracetamol or where contraindicated

Early interdisciplinary assessment and intervention

A patient's rehabilitation needs and goals are to be assessed by staff trained in rehabilitation within 24 to 48 hours of admission, with rehabilitation started as soon as possible.[9] It is important that a formal assessment for rehabilitation is performed for all patients after stroke, as those patients with mild stroke often have impairments that can be overlooked unless specific assessments are conducted. Similarly, the rehabilitation needs of patients with severe stroke are inconsistently documented and these patients are not routinely referred to rehabilitation services for ongoing rehabilitation.[9]

One component of stroke unit care and rehabilitation is early mobilisation. "Mobilisation" is defined as out-of-bed activities, and can include sitting out of bed, standing and walking.[13] Patients treated on a stroke unit were more likely to be mobilised during their admission than those patients not treated in a stroke unit (Table 28).

Table 28. Mobilisation, by stroke unit access

Mobilisation	Australia (N=3890)	Treated in a stroke unit (N=2844)	Not treated in a stroke unit (N=1046)
Mobilisation during admission	**88%**	94%	74%
Mobilisation during admission if unable to walk independently on admission	**82%**	90%	61%
Mobilisation on same day or day after arrival to ED	**83%**	83%	83%
Mobilisation on same day or day after arrival to ED if unable to walk independently on admission	**76%**	75%	76%
Mobilisation within 2 days of arrival to ED	**94%**	94%	93%
Mobilisation within 2 days of arrival to ED if unable to walk independently on admission	**90%**	90%	89%

ED: emergency department

Twenty-nine percent of patients had urinary incontinence documented within the first 72 hours of stroke onset. Of these, only 36% were found to have a documented incontinence management plan (37% in 2019). An indwelling catheter was reported in almost half (43%) of cases within the first week of admission. A documented incontinence plan was more common if patients were treated in a stroke unit (38%) compared to not in a stroke unit (32%).

A larger proportion of patients treated in a stroke unit:
- received malnutrition screening (82% if treated in a stroke unit vs 55% if not treated in a stroke unit)
- had their mood assessed (38% if treated in a stroke unit vs 18% if not treated in a stroke unit).

Table 29 details the communication between patients and families with the treating team, including goal setting.

Table 29. Patient communication, by region and stroke unit access

	Australia (N=3890)	Major Cities (N=2334)	Inner Regional (N=1131)	Outer Regional ^ (N=425)	Treated in a Stroke Unit (N=2844)	Not treated in a Stroke Unit (N=1046)
Goals set with input from team and patient	**84%**	90%	76%	76%	89%	71%
Patient and/or family received information covering stroke, hospital management, secondary prevention and recovery	**64%**	67%	60%	55%	71%	44%

^Outer Regional classification includes one Remote stroke service

Although most patients with stroke were assessed by a physiotherapist, occupational therapist and/or speech pathologist during their hospital admission, fewer patients were assessed by a dietitian or a social worker. Rarely were assessed by a psychologist during acute admission. Patients not treated in a stroke unit had less access to all allied health therapies, especially social work services (Table 30).

Table 30. Interdisciplinary assessment, by region and stroke unit access

	Australia (N=3890)	Major Cities (N=2334)	Inner Regional (N=1131)	Outer Regional^ (N=425)	Treated in a Stroke Unit (N=2844)	Not treated in a Stroke Unit (N=1046)
Physiotherapy						
Assessed*	**95%**	97%	94%	88%	98%	87%
Assessed within 48 hours	**81%**	82%	81%	71%	84%	70%
Occupational Therapy						
Assessed†	**93%**	94%	92%	85%	96%	82%
Assessed within 48 hours	**63%**	63%	68%	57%	66%	54%
Speech Pathology						
Assessed†	**91%**	91%	91%	88%	95%	80%
Assessed within 48 hours	**75%**	74%	77%	71%	78%	64%
Dietetics						
Assessed†‡	**70%**	71%	70%	70%	74%	61%
Median time to assessment	**2 days**	2 days	2 days	2 days	2 days	2 days
Social Work						
Assessed	**65%**	68%	63%	55%	71%	48%
Median time to assessment	**2 days**	2 days	2 days	2 days	2 days	2 days
Psychology						
Assessed§†	**15%**	20%	3%	12%	18%	2%
Median time to assessment	**5 days**	6 days	2 days	5 days	5 days	2 days

^Outer Regional classification includes one Remote stroke service
*Excludes where patient declined
†Excludes where not required
‡If nutrition or hydration problems on admission or if failed swallow screen
§If mood impairment identified on admission

Early rehabilitation

Patients not treated in a stroke unit were less likely to commence rehabilitation within 48 hours of initial assessment, receive treatment based on identified rehabilitation goals, or have an assessment for rehabilitation (Table 31).

Assessment for rehabilitation was primarily undertaken by the multidisciplinary team (75%), multidisciplinary team consists of medical, nursing, and allied health professionals, including occupational therapy, physiotherapy, speech pathology, social work, and dietetics. Only two thirds of all patients (67%) received an assessment for rehabilitation, even though the majority (69%) of those who had an assessment for rehabilitation had an identified need for ongoing rehabilitation.

Table 31. Rehabilitation standards, by region and stroke unit access

	Australia (N=3890)	Major Cities (N=2334)	Inner Regional (N=1131)	Outer Regional^ (N=425)	Treated in a Stroke Unit (N=2844)	Not treated in a Stroke Unit (N=1046)
Assessment for rehabilitation performed	67%	71%	63%	56%	74%	47%
Use of the Assessment of Rehabilitation Tool*†	27%	29%	24%	24%	28%	24%
Assessment identified need for ongoing rehab‡	69%	66%	74%	75%	68%	73%
Referral made for ongoing rehabilitation (if need identified)	92%	92%	94%	90%	93%	88%
Referral made for ongoing rehabilitation (all patients)	46%	46%	48%	41%	51%	34%

^Outer Regional classification includes one Remote stroke service
*Excludes if patient declined, had returned to pre-morbid level, was unresponsive, or treatment was futile
†Of those who had assessment
‡If assessment performed, excludes unknown responses

Minimising risk of another stroke

At the point of discharge from the service, 22% of patients miss out on advice that can help to reduce the risk of subsequent stroke and only half (49%) are given smoking cessation advice (Table 32).

Table 32. Secondary prevention indicators, by region and stroke unit access*

	Australia (N=3890)	Major Cities (N=2334)	Inner Regional (N=1131)	Outer Regional^ (N=425)	Treated in a Stroke Unit (N=2844)	Not treated in a Stroke Unit (N=1046)
Patient education about behaviour change for modifiable risk factors†	78%	82%	72%	75%	81%	69%
Smoking cessation advice if patient currently smoking or recently quit†	49%	54%	42%	42%	55%	33%

^Outer Regional classification includes one Remote stroke service
*Only includes patients discharged from stroke service
†Excludes patients who refused, futile, or patients with severe cognitive impairment or severe communication impairment

For patients with ischaemic stroke with atrial fibrillation (both paroxysmal and permanent), oral anticoagulation is recommended for long-term secondary prevention.[9] Patients with atrial fibrillation treated in a stroke unit and in major cities are more likely to be discharge on appropriate medication. Antihypertensive medication on discharge appeared slightly lower if treated in a stroke unit (Table 33).

Table 33. Discharge medication indicators, by region and stroke unit access*

	Australia (N=3890)	Major Cities (N=2334)	Inner Regional (N=1131)	Outer Regional^ (N=425)	Treated in a Stroke Unit (N=2844)	Not treated in a Stroke Unit (N=1046)
Discharged on oral anticoagulants for atrial fibrillation (ischaemic stroke)‡	**78%**	80%	75%	73%	81%	67%
Discharged on antihypertensives (all stroke)‡	**78%**	76%	81%	76%	77%	81%
Lipid-lowering treatment on discharge (ischaemic stroke)‡	**92%**	92%	91%	89%	93%	89%
Antithrombotic on discharge (ischaemic stroke)‡	**99%**	99%	99%	96%	99%	98%

^Outer Regional classification includes one Remote stroke service
*Only includes patients discharged from stroke service
‡Excludes patients where treatment was contraindicated, futile, or refused

Transition from hospital stroke service care

Effective discharge planning facilitates the transfer of the stroke survivor to the community by maximising independence, minimising social isolation, and ensuring that the needs of the patient and carer are addressed.[9]

Eight hundred and thirteen patients (29%) were reported to have a carer. However, only 65% of carers of a stroke survivor discharge to the community received a support needs assessment, and 64% of carers received relevant training. Almost one-quarter (24%) of patients did not have a care plan developed, and 32% of patients did not receive contact details of someone in the hospital stroke service for post-discharge questions (Table 34). Those patients treated in a stroke unit were more inclined to receive a care plan for discharge (stroke unit:80% vs 62%) or contact details (stroke unit: 73% vs 53%).

Table 34. Discharge planning indicators, by region and stroke unit access*

	Australia (N=3890)	Major Cities (N=2334)	Inner Regional (N=1131)	Outer Regional^ (N=425)	Treated in a Stroke Unit (N=2844)	Not treated in a Stroke Unit (N=1046)
Care plan developed with the patient and the team (or family)*	**76%**	84%	63%	64%	80%	62%
Patient involvement in care plan†	**94%**	94%	92%	97%	94%	92%
Family involvement in care plan†	**63%**	66%	57%	60%	63%	63%
Copy of discharge summary sent to the general practitioner and/or community providers‡	**96%**	96%	97%	92%	96%	95%
Patient or family received contact details provided of someone in hospital for post-discharge questions‡	**68%**	75%	55%	61%	73%	53%

*Excludes death, if transferred to inpatient rehabilitation, acute care or refused plan, or where not applicable
^Outer Regional classification includes one Remote stroke service
†If had care plan
‡Excludes deaths

Chapter 5: Clinical Audit Changes Over Time

Changes in key performance indicators over time provide a useful comparator to assess clinical practice. Table 35 includes all services that completed any of the last three cycles (matched analysis of 96 stroke services that participated in all the 2017, 2019 and 2021 audits is included in the supplement document).

Multivariable regression models were used to assess the year effect (reflective of the audit year) on adherence to these indicators, considering age, sex, independence prior to admission, stroke type, stroke severity, and hospital clustering (refer to Appendix for more details).

There were significant improvements for nine indicators (highlighted in green), with a reduction in median time from onset to thrombolysis (highlighted in red).

Table 35. Changes over time to the Acute Stroke Clinical Care Standard Indicators and recommended national quality indicators

Australia	2017 (115 services)	2019 (115 services)	2021 (104 services
Validated stroke screen in the emergency department	46%	52%	69%
Thrombolysis in ischaemic stroke	11%	10%	11%
Thrombolysis in ischaemic stroke within 60 mins of hospital arrival	30%	32%	27%
Median time from onset to thrombolysis	2:36	2:45	2:50
Swallow screen or swallow assessment performed before given oral intake (medications, food, and fluids)	57%	55%	60%
Swallow screen or swallow assessment performed within 4 hours of arrival to the emergency department	19%	23%	30%
Hyperacute antiplatelet administered within 48 hours (ischaemic stroke)	71%	70%	79%
Received stroke unit care	69%	67%	73%
Received 90%+ of acute care in a stroke unit	45%	41%	47%
Assessment by a physiotherapist within 24-48 hours of arrival to emergency department	67%	73%	81%
Assessed by occupational therapy within 48 hours of arrival to emergency department	54%	57%	63%
Assessed by speech pathologist within 48 hours of arrival to emergency department	69%	70%	75%
Mood assessed during admission	22%	27%	32%
Incontinent patients with continence management plan	33%	37%	38%
Patient received education about behaviour change for modifiable risk factors	70%	72%	78%
Antihypertensives on discharge (all stroke types)	77%	77%	78%
Lipid-lowering treatment on discharge (ischaemic	86%	88%	92%
Antithrombotic on discharge (ischaemic stroke)	98%	98%	99%
Discharge on oral anticoagulants for atrial fibrillation (ischaemic stroke)	70%	74%	78%
Discharge on statin, antihypertensive and antithrombotic medications (ischaemic stroke)	69%	69%	72%
Carer received support needs assessment	62%	63%	65%
Carer received relevant training	57%	61%	64%
Assessment for ongoing rehabilitation completed using a structured assessment tool prior to discharge	59%	61%	67%
Care plan developed with the team and the patient (or family alone if patient has severe aphasia or cognitive impairments)	65%	69%	76%

Chapter 6: Discussion and Recommendations

The National Stroke Audit - Acute Services Report 2021 provides a comprehensive snapshot of current hospital care for stroke in Australia. Importantly, the results are presented according to the *Clinical Guidelines for Stroke Management* and the Australian Commission on Safety and Quality in Healthcare's (ACSQHC*) Acute Stroke Clinical Care Standards*, and progress since the last National Stroke Audit is described. Overall, it is positive to see incremental improvements across a range of stroke care indicators.

Framework elements

In the Organisational Survey there was an increase in the number of elements met from the Framework, with the largest proportion of services meeting 17 of the 20 elements (median of 16). Large services provide care to most people with acute stroke, so it is of concern that only 10 of the 20 services admitting 500 or more patients with stroke over the past 12 months were found to have met all 20 elements of the Framework qualifying them as a CSC. Furthermore, 9 services (eight small, and one medium, annual stroke numbers) met less than half of the Framework elements.

The elements with the least compliance (excluding on-site endovascular thrombectomy or neurosurgical services) included having rapid TIA services (50%), routine use of guidelines, care plans and protocols (68%), a dedicated stroke coordinator (70%), and access to other specialist services (70%).

Community awareness of the Face Arm Speech Time (FAST) message

A stroke is a medical emergency. The longer a stroke remains untreated, the greater the chance of stroke-related brain damage and awareness of stroke signs and early action is essential. The median time from stroke onset to arrival in the ED was 4 hours:18 minutes in this audit, substantially larger than the 3 hours:36 minutes in 2019. Thirty percent of patients arrived at hospital within 3 hours, and 37% arrived within 4.5 hours of stroke symptom onset similar numbers to the 2019 audit (28% arrived with 3 hours; 35% within 4.5 hours). It could be the longer median arrival times may be due to milder strokes demonstrating greater hesitancy to call an ambulance and overload the health system during the COVID-19 pandemic.

Analysis of the Australian Stroke Clinical Registry (AuSCR) data found no change in the median onset to arrival times during the COVID period but there was an increase in the use of ambulance services.[14] Previous Australian data found patients with stroke who use ambulances arrived faster and were more likely to receive thrombolysis compared to those using personal transport.[15] Irrespective, it is clear greater awareness of stroke using the established FAST messaging is needed to ensure earlier hospital arrival.

System wide coordination of services

State-wide coordination is recommended to ensure efficient and equitable access to acute stroke services. Results of this audit highlight that more needs to be done across all jurisdictions to ensure better coordination of acute stroke services.

It is imperative that those responsible for state-wide health system delivery work with the relevant ambulance and pre-hospital emergency services to ensure a consistent approach to accessing stroke-capable centres in their jurisdiction. This should include state-wide protocols for the early notification of suspected acute stroke patients to the initial hospital, secondary transfers for additional treatment to CSCs or hub services and subsequent repatriation transfers for further acute, rehabilitation or palliative care services. Emergency services that employ a dedicated state-wide stroke coordinator can ensure appropriate policies and processes are developed and monitored in cooperation with the health system.

In regional and rural areas, the use of telehealth is strongly recommended to provide specialist assessment and management support to general hospital centres within agreed systems of care and has been shown in this report to provide improved acute care. Telehealth is also applicable for stroke assessments including rehabilitation, remote therapy provision, education and support following hospital discharge, reducing the need for patients and their families to travel long distances.

Time-critical therapy access

Acute stroke services should provide access to time-critical therapies, such as thrombolysis and endovascular thrombectomy. More services are offering thrombolysis (88% vs 82% in 2019), but the national thrombolysis rate has been stagnant around 11% over the last three audits. Thrombolysis rates reported in the AuSCR data have similarly failed to substantially improve (14% in 2018, 11% 2019, 11% 2020).[16] The AuSCR involves mostly larger centres compared to the audit which includes additional smaller and regional centres but reflects the major city cohort in this report (13% thrombolysis).

Thrombolysis is to be administered as early as possible after onset of ischaemic stroke, but the therapeutic time window has expanded in recent years due to selection with advanced brain imaging.[9] The national median time from onset of stroke symptoms to thrombolysis was 2 hours:50 minutes (Q1: 2:15; Q3: 3:45), extended from 2 hours: 45 minutes in 2019. We are unsure if this is due to the extension of the time window for thrombolysis to be administered or inefficiencies within the system. The median stroke onset to thrombolysis in regional hospitals was an hour shorter with telehealth support (telehealth 2 hrs 48 mins vs 3 hrs 47 mins).

In this report, 31 services reported thrombolysing fewer than 10 patients in the past 12 months. Services that undertake larger numbers of thrombolysis have been found to have improved hospital efficiencies (door-to-needle times) and fewer complications.[17] Therefore, it is important to support smaller services particularly in regional centres, ideally by a formal telestroke support system. Queensland is the only major state without a formal state-wide telestroke service. A sub-analysis performed on thrombolysis access in regional hospitals clearly demonstrates improved access to life saving care at significantly shorter timeframes with a telestroke service. This mirrors the results demonstrated in the evaluation of the Victorian Stroke Telemedicine program.[18]

The main concern from this report is the lower door-to-needle times, with only 27% of those who received thrombolysis being treated within 60 minutes of hospital arrival (32% in 2019). This remains significantly lower than hospitals in the UK and USA which are over 60%.[19-22] Among the hospitals that contribute to AuSCR 31% of patients received thrombolysis within 60 minutes of arrival. Importantly the delay to treatment appears to be from scan to needle times given the median door to scan times was an acceptable 23 minutes (median scan to needle time 55 minutes) in this cohort. This is similar to data in the AuSCR.

It is unclear why the metrics around thrombolysis have stagnated and, in some states, even gone backwards. Many of the trend's pre-date COVID-19 but clearly COVID has had a significant impact in some hospitals. Patient factors (reluctance to call ambulance), local factors (selection criteria using perfusion scanning, trial involvement) and system wide factors (lack of telestroke services, decentralisation of thrombolysis centres and dependence of smaller centres on consultation with comprehensive stroke services) are likely to all contribute.

Access to endovascular thrombectomy interventions has risen dramatically over the last four years, as reported in the Organisational Survey. While this is encouraging, it is imperative that all patients, in all regions in Australia, have a clear pathway to be transferred for endovascular thrombectomy if clinically indicated. Further access to advanced brain imaging (e.g., computed tomography angiography, computed tomography perfusion) will assist sites determine who is most appropriate for transfer to CSCs.

In this report states with organised systems of care (including telestroke and referral pathways) tend to have higher levels of reperfusion therapy. Per capita rates of endovascular thrombectomy are highest in the Australian Capital Territory and South Australia (13 endovascular thrombectomy procedures per 100,000 population) followed by Western Australia (12 per 100,000) and then Victoria (9 per 100,000), all of which are above the national average (8.5/100,000).

The Framework recommends that endovascular thrombectomy services be available 24/7, however of the 20 services that reported endovascular thrombectomy services, five (25%) did not provide 24/7 access. State access to endovascular thrombectomy services also varied, with the Northern Territory and Tasmania having no endovascular thrombectomy services. Efforts need to continue to ensure there is equitable access to sustainable services across the country.

Stroke unit access and care

Access to stroke unit care has improved slightly since the last audit in 2019 (67% in 2019 to 73% in 2021). Access is better in New South Wales and the Australian Capital Territory, with Queensland and South Australia also achieving good results. The impact of COVID-19 in Victoria is apparent in this report and reflects the challenges more broadly.[14] Nationally stroke unit access varied from 41% in the Northern Territory to 94% in the Australian Capital Territory, as well as regionally from 84% in metropolitan areas to only 41% in outer regional areas.

The median time from hospital arrival to admission to a stroke unit was 6.7 hours (7.6 in 2019) and of these patients, only 47% received at least 90% of their care on a stroke unit (41% in 2019). Increasing admission rates to a stroke unit is the factor likely to have the single biggest impact on stroke morbidity and mortality, due to the many facets of coordinated and improved care that result. Encouraging equity of access is important. Recent evidence has shown that patients with dementia are less likely to be treated in stroke unit.[23] However, these patients still benefit from stroke unit care with fewer complications and better access to rehabilitation.

Routine use of guidelines, care plans and protocols were reported more at services with stroke units (75%) than services without a stroke unit (36%). Patients admitted to a stroke unit received better treatment rates for key issues such as:
- swallow screening and assessment (more patients on a stroke unit were screened within 24 hours of admission)
- malnutrition screening (82% compared with 55%)
- incontinence management plan (38% compared with 32%)
- mood assessment (38% compared with 18%)
- mobilised during admission (94% compared with 74%).

TIA services

The vast majority (86%) of services report a defined process, policy or pathway for TIA patients. While the early risk of stroke after TIA is slightly lower than previously reported and different models exist across Australia (admission, TIA clinics), access to outpatient TIA clinics was reported to be 5 days on average which is longer than timeframes recommended for specialist assessment.

Access to rehabilitation

Assessment for rehabilitation was undertaken in 67% of all patients. Of those assessed, 69% of patients had a need for ongoing rehabilitation identified and 92% of these patients were referred for ongoing rehabilitation. Assessment for rehabilitation should be closer to 90% with the national benchmarks found to be 94%. Given the high need of ongoing rehabilitation it is concerning that 33% of patients are not provided an initial rehabilitation assessment. Patients not treated on a stroke unit were less likely to commence rehabilitation within 48 hours of initial assessment, receive treatment based on identified rehabilitation goals, or have an assessment for rehabilitation compared to patients treated on stroke units. The disruption of inpatient rehabilitation services due to COVID-19 remains unclear with rapid adaption of telehealth services to facilitate early hospital discharge. Irrespective, thorough assessment of ongoing rehabilitation needs within the acute hospital stay is vital.

Secondary prevention

At the point of discharge from the service, 22% of patients did not receive advice about risk factor modification, were not prescribed antihypertensives and, of ischaemic stroke patients with atrial fibrillation, were not prescribed anticoagulants.

There is much variability across the country in terms of patient education on risk factors and behaviour change for modifiable risk factors: a low of 58–68% of patients are receiving this education in the Northern Territory and Victoria, compared with a high of 98% in the Australian Capital Territory. Smoking cessation was a new indicator included in this year's report with a surprisingly low rate of advice (49%) provided to patients who were current smokers or had recently smoked. Patients treated on a stroke unit were more likely to be provided with education on behaviour change for risk factors (81% on a stroke unit vs 69% not treated on a stroke unit) and smoking cessation advice (55% on a stroke unit vs 33%).

The proportion of patients discharged on appropriate medications for secondary stroke prevention also varies around the country. Lipid-lowering and antithrombotic therapy on discharge are consistently provided to the vast majority of cases, however, oral anticoagulation and blood lowering therapy are missed in one in five cases. Given the proven effects of secondary prevention strategies in reducing recurrent stroke risk, these gaps in care have significant implications for individuals and the healthcare system. Review of processes to ensure appropriate risk factor education and medication prescription is warranted, especially since one in three patients discontinue their medications in one year.[24]

Support for transition from acute stroke service to private accommodation

Stroke survivors, their carers and families report that the transition from acute stroke service after stroke is a critical point in their recovery. The restrictions to visitors experienced during the COVID-19 pandemic have highlighted a need for the stroke community to work more closely in partnership with carers and prepare tailored carer support programs.

Small improvements for related indicators are reported in this audit. Despite this, only 65% of carers received a support needs assessment, and only 64% of carers received relevant training. Almost one quarter (24%) of patients did not have a care plan developed, and 32% of patients did not receive contact details of someone in the stroke service for post-discharge questions. Of those patients not treated in a stroke unit, only just over half received a care plan (62%) or contact details of someone in the stroke service for post-discharge questions (53%), again reinforcing the importance on getting more people into stroke unit care. Given the complexity of stroke, care plans provide an essential service and are recommended for all patients.

Specialist staffing

Stroke care coordinators (SCCs) were reported at 70% of services. Many of the SCCs were based in major cities (73%) and inner regional (76%) locations, with a lower representation in outer regional areas (44%). The presence of a defined SCC role has been found to improve clinical processes of care and reduce the length of stay in services with a stroke unit.[25] Therefore, this coordination role appears critical to the benefits found in stroke unit care. However, the title and role of health professionals in coordination positions varies.

A recent survey reported that up to two-thirds in coordination roles do not have the title of 'stroke coordinator', but may be a CNC, stroke liaison nurse or nurse practitioner.[26] Encouragingly, 25 services (22% of 115 services) that did not have an SCC reported a specialist nurse (Clinical Nurse Consultant and/or Clinical Nurse Specialist) actively involved in the management of patients with stroke. Nevertheless, further work is required to understand the roles and responsibilities of SCCs and other staff in coordinator roles to ensure they maximise the benefits of patient care throughout the stroke survivor's journey.

Medical leadership specific to stroke outside of major cities locations could be improved and telehealth services can assist in supporting regional/remote services. While stroke specialisation for acute stroke care is usually led by a neurologist, it may also be under a geriatrician or, in rare cases, general physicians. This audit has found a need for more stroke specialist staffing to ensure all aspects of care (from hyperacute management to TIA services, secondary prevention, and discharge care planning) is provided by doctors who specialise in stroke care. Access to telehealth services for shared clinical decision making for acute stroke in some way may address the lack of access to stroke medical specialists in regional/remote locations.[18]

Quality improvement and data collection

Although 90% of the services reported staff access to a program of continuing education on the management of stroke, there was variability across the states and territories, ranging from 67% in Tasmania and South Australia, to 100% in New South Wales, the Australian Capital Territory, and the Northern Territory. The National Stroke Audit promotes the delivery of evidence-based stroke care by providing longitudinal data on resources and clinical performance, with national and state comparative data, as well as CSCs/PSCs, major cities/inner regional/outer regional, stroke unit/no stroke unit, and annual stroke admission breakdowns. The National Stroke Audit has provided strong impetus to improve stroke systems of care and increase individual patient care, however ideally all services need to participate for continuous assessment and benchmarking.

6.1 Strengths and limitations of the data

Strengths of the data

The audit provides a cross-sectional overview of acute stroke services in Australia. The sample size provides a robust and reliable overview of acute services and their adherence to stroke clinical guidelines. Furthermore, the following strategies were used to minimise potential biases:

- Use of a thorough process of standardised training for data auditors/abstractors, with ongoing support throughout the audit process.
- A comprehensive data dictionary was provided to assist interpretation of both the Organisational Survey and Clinical Audit questions.
- Each service conducted a reliability check in which data from three to five cases were entered by two auditors for comparison.
- Programmed logics were built into the AuSDaT to verify data at the point of entry and independent logic checks of completed data were conducted by Monash. The completed data logic check reports are sent to each service for verification.
- Data were de-identified, then de-identified analysed by an independent organisation, which minimised interpretation bias.

Limitations of the data

There are several limitations to the data that readers of this report should consider:

- Participation in the National Stroke Audit is voluntary and data self-reported, therefore, may be subject to reporting bias or response bias.
- Documentation issues should be considered; the Clinical Audit assumes that if a process were not documented, it was not performed, which may not always be the case. This is highlighted when data from the Organisational Survey and Clinical Audit provide conflicting information. However, as documentation of care is a medico-legal responsibility, where proof that care was delivered is required, care cannot be assumed in the absence of documentation. Better documentation will provide the ability to gather more robust data for monitoring stroke care and should be factored into all quality improvement activities.
- The audit is undertaken once every two years, and the patient cohort was relatively small in several of the participating services. Application of exclusion criteria and missing data further reduced the sample size for some indicator level analyses, e.g., carer training.

6.2 Recommendations

The cost of poor outcomes, and the benefits that can be achieved by the delivery of appropriate interventions, highlight the value of regular monitoring of care and ongoing efforts to improve quality. It is clear more effort needs to be applied by all if we are going to adequately serve the needs of our communities. The key messages of the national acute services audit are:

- Increase awareness of the signs of stroke and that stroke is a time-critical medical emergency.
- Improve equity of access to reperfusion therapies especially in regional, rural, and remote areas. Formal policies and pathways across the whole healthcare system are needed to connect dedicated stroke centres to other hospitals via telehealth.
- Improve earlier access to thrombolysis to match international benchmarks.
- Improve access to dedicated stroke unit care and ensure most of the acute care is provided within this unit. Stroke unit teams must have clear medical leadership and a dedicated stroke care coordinator who are actively involved in care.
- Improve holistic patient care including a greater focus on swallow screening, mood assessment and management of incontinence.
- Ensure carers are assessed, trained, and connected to community support prior to patient discharge.
- Ensure all patients are supported through comprehensive discharge processes including a thorough assessment for rehabilitation and a holistic patient-centred discharge care plan.

Appendix: Audit Program Methodology

Development of the National Stroke Audit questions
The National Stroke Audit was first developed under the guidance of a National Advisory Committee including national representation from medical, nursing, allied health, and clinical research groups.[27] Some items contained in the National Stroke Audit have been refined over time based on feedback from previous years and changes in national reporting standards or the clinical guidelines. However, most items have remained consistent from year to year to allow comparisons over time. Data collected include:

- Demographic characteristics
- History of risk factors
- Stroke severity measures
- 30+ evidence-based processes of care
- In-hospital outcomes.

Organisational Survey
Data collected through the Organisational Survey enables reporting of services against each required element outlined in the Framework. The Organisational Survey questions have been reviewed based on the Framework and comments received from previous National Stroke Audits. All feedback has been discussed and changes approved by the Stroke Foundation Clinical Council.

The Framework makes recommendations about the resources required to provide evidence-based care. Some changes were made to the Organisational Survey to better understand the hyperacute care patients receive. New or changed questions in the Organisational Survey include:

- How many of these patients with stroke were specifically coded as ischaemic strokes? (ICD-10 codes 163.0 - 163.9)
- How many patients from your hospital have been transferred for endovascular thrombectomy at another hospital during the previous calendar year?

Recommendations for state-wide systems of care as well as hospital-level procedures are included in the Framework. Therefore, the state clinical networks were asked to complete a spreadsheet with four organisational questions related to system-wide services.

Clinical Audit
The Clinical Audit involves a systematic process of abstracting data from patient medical records. The data collected through the Clinical Audit are designed to report on adherence to recommendations outlined in the *Clinical Guidelines for Stroke Management*. The Clinical Audit questions have been reviewed to correspond with the *Clinical Guidelines for Stroke Management*[9] and adjusted based on comments received from previous National Stroke Audits. All feedback has been discussed and changes approved by the Stroke Foundation Clinical Council. Audit results are also presented based on the ACSQHC *Acute Stroke Clinical Care Standard* with associated indicators[2].

To ensure standardised data collection and reporting in Australia, the *National Stroke Data Dictionary* (NSDD)[28] is used for the National Stroke Audit. The NSDD is regularly reviewed and updated in accordance with the AuSDaT *National Stroke Data Dictionary Operational Policy*.[29] The ACSQHC indicators were reported using the definitions included in the ACSQHC Standard.[3]

The fifteen key performance indicators assess quality of care and have been determined by expert opinion, statistical significance, level of evidence, influence on patient outcome measures, international comparison, consumer consultation of stroke survivors and their carer's. These clinical indicators are consistent with current practice recommendations so that clinicians may use the indicator set in a meaningful and continuous way. Definitions of the indicators reported (including numerators and denominators, and exclusion criteria) are available in the supplement document available on the Stroke Foundation Informme website (www.informme.org.au/stroke-data).

New or changed clinical indicators include:
- Assessment by a physiotherapist within 24-48 hours of arrival to emergency department
- Assessment for ongoing rehabilitation completed using a structured assessment tool prior to discharge
- Antihypertensives on discharge (all stroke types)
- Lipid-lowering treatment on discharge (ischaemic stroke)
- Antithrombotic on discharge (ischaemic stroke)

Clinical indicators that have been removed include:
- Patient transported to a hospital able to provide thrombolysis.
- Thrombolysis in ischaemic stroke for those who arrive within 4.5 hours of symptom onset.
- Rehabilitation therapy commenced within 48 hours of initial assessment.
- Treatment for a rehabilitation goal commenced during acute hospital admission.
- Antihypertensives on discharge (haemorrhagic stroke)
- Discharge on lipid-lowering, antihypertensive and antithrombotic medications (ischaemic stroke).

In feedback from previous audits, auditors requested that the number of questions for data collection be reduced. This year participating services that collect data for the AuSCR were able to use data entered in AuSCR for the National Stroke Audit. Western Australia also created an in-house data collection system that allowed relevant data to be imported for use in the National Stroke Audit. Both systems reduced the burden of data entry for services participating in the National Stroke Audit.

Recruitment
Any service admitting at least 40 patients with acute stroke was eligible to participate in the Organisational Survey component. Services admitting 40 or more patients with stroke per year were invited to participate in the Clinical Audit. Smaller services were able to participate in the Clinical Audit but were not actively recruited. Eligible services were identified through previous participation in the National Stroke Audit, partnerships with state-based clinical networks and relationships with key health providers.

Services were recruited between December 2020 and February 2021, in which chief executives and the main contacts from both public and private services were sent a letter of invitation. Services were asked to complete and return a consent form to confirm participation. Services were also requested to give permission for the Stroke Foundation to share summarised data with relevant state-based clinical networks or Departments of Health, to promote transparency and facilitate support for quality improvement. Each participating service nominated a hospital audit coordinator to receive all correspondence during the National Stroke Audit period. The hospital coordinator was responsible for data completion and data quality for the audit at their service.

Training
The AuSDaT was used to enter data for the 2021 National Stroke Audit. This is a purposefully designed, integrated, web-based data collection and management platform. The audit program transitioned from the Stroke Foundation online system to the AuSDaT in 2015 and it has been designed to reduce the data entry burden and time for data collection. All auditors were required to complete standardised training regarding the AuSDaT, and the NSDD was made available to give a rationale for each question as well as definitions and help notes. The Stroke Foundation project team were always available for questions leading up to, and during, the data collection period. For more information regarding AuSDaT, please refer to the Australian Stroke Coalition website (https://australianstrokecoalition.org.au/projects/ausdat/).

Data collection
All respondents from participating services completed the Organisational Survey via the AuSDaT in February - April 2021. The full list of Organisational Survey questions is presented online in the supplement document. For more high-level Framework recommendations the state clinical networks were asked to complete the spreadsheet of state-wide system questions in July 2021.

Between 18 February and 31 May 2021, those services participating in the Clinical Audit completed a retrospective case note audit of up to 40 consecutive stroke admissions to their service. To minimise selection bias, data for the first 40 consecutive acute stroke admissions over a pre-defined time period were extracted. For most of these episodes, admission and discharge dates fell between 1 July and 31 December 2020, with the recommendation to start with the most recent inpatient admission/discharge date and work back.

Patients with an ICD-10 code of I61.0–I61.9 (intracerebral haemorrhage), I63.0–I63.9 (cerebral infarction), I64 (stroke not specified as haemorrhagic or infarction) and I62.9 (intracerebral haemorrhage unspecified) were eligible for inclusion. The specificity for diagnosing stroke (any type) using these ICD-10 codes is greater than 95%.[30] The full list of Clinical Audit questions is presented online in the report supplement document.

Auditors at participating services were required to log in to enter and access data on the AuSDaT. Security and confidentiality were maintained by each auditor having an individual account, with email and password specific to the auditor. No patient-identifying data were collected by the Stroke Foundation. However, to facilitate the data verification processes, services were asked to keep a list of the cases they entered for their own records.

Data quality checks

The AuSDaT contains pre-defined data fields with inbuilt programmed logic checks. Manual reliability checks are also performed via re-auditing of 3–5 cases by another auditor. This helps to ensure data is being reliably collected by identifying whether a case note audited independently by two people provides the same responses. A total of 190 reliability records were completed and the results are available in the supplement document. Coordinators were also asked to check their service data at completion of the data collection period, to maximise the accuracy of the data and minimise missing items. The results of this data quality procedure are not reported here, but the information gathered will be used to refine future National Stroke Audits.

Data verification

Auditors were able to update their entered Clinical Audit data up until 16 July 2021, at which point all data were locked. Programmed logic checks of the data were then conducted and used to validate data from the Organisational Survey and the Clinical Audit. Queries were sent back to services where assumptions about true values could not be made. Where data appeared incorrect, further changes were permitted. The final, cleaned data were then used for the analysis process.

Data analysis

Staff from the Translational Public Health and Evaluation Division, Monash University, independently analysed the anonymised data. Names of services were excluded from the data submitted to Monash University; only the site identification number was provided.

The data were analysed using computer software including Stata 15.0 (StataCorp. 2017. Stata Statistical Software: Release 15. College Station, TX: StataCorp LLC) and Excel (Microsoft Excel 2016). The data were exported from the AuSDaT as an Excel spreadsheet and transferred into Stata.

All Organisational Survey and Clinical Audit data were aggregated to provide national estimates. Subcategories for analyses included breakdown by state, regional status, public/private status, annual stroke admissions and presence of a stroke unit.

The few patients with stroke type recorded as TIA were analysed as having ischaemic stroke, due to these patients often being clinically managed in a comparative manner to patients with minor ischaemic stroke.

For medical history and impairment data, only valid responses (e.g., Yes/No) were included in the analysis. 'Not documented' responses to these questions were reported separately and were excluded from the denominator. Data relating to processes of care, e.g., received advice about risk factor modification, 'not documented' and 'unknown' responses, were assumed to be negative (e.g., a care process not provided) and were included in the denominator.

Adherence to processes of care was generally calculated on the entire sample. When reporting adherence to care, 'Known N' refers to all eligible patients. In some instances, eligibility criteria for processes of care were specified. For example, adherence to the process of care relating to the use of antithrombotic on discharge was calculated only for patients presenting with ischaemic stroke who were discharged.

To minimise data being excluded, cases with known dates but unknown times for processes of care had an assumed time of 23:59:59 allocated to them. For patients suffering an in-hospital stroke, stroke onset date and time were used for date and time of ED presentation. Derived variables relating to outcomes of care, such as length of stay, were calculated based on admission and discharge dates.

The median (50th percentile) and first (Q1) and third (Q3) quartiles (25th percentile and 75th percentile) were reported for skewed (e.g., data not normally distributed) continuous data from questions such as the number of stroke admissions each year.

The Achievable Benchmark of Care (ABC™) methodology was used to create benchmarks for several nationally relevant indicators based on the average performance of the top 15% of services for each indicator.[11]

Generally, descriptive statistics are presented in this report. An additional matched analysis of 96 stroke services that participated in all the 2021, 2019 and 2017 audit cycles was completed to assess the "year effect" or association of year (reflective of the year the audit cycle was conducted) and adherence to clinical indicators. The matched analysis is included in the supplement document to this report and is available on the Stroke Foundation Informme website. Multivariable, multi-level, logistic regression models were used to account for hospital-level variation, and included patient variables of age, sex, independence prior to admission, stroke type, and validated severity factors.

Acute Service Regional Classifications

Classification of participating services as metropolitan/major cities or regional/rural was based on the Accessibility and Remoteness Index of Australia (ARIA+).[31] The Australian Statistical Geography Standard (ASGS) defines Remoteness Areas into five classes of relative remoteness across Australia.[32] The five classes of remoteness are determined using a process that allows statistical data to be classified in a consistent way with which users can analyse changes in data for different remoteness categories over time. The audit only used three classes of remoteness (Major Cities of Australia, Inner Regional Australia, Outer Regional Australia) as only one of the participating services are classified as Remote Australia and the decision was made to include them in the outer regional classification.

Relative remoteness is measured in an objective way using the Accessibility and Remoteness Index of Australia (ARIA+), which is developed by the Hugo Centre for Migration and Population Research at the University of Adelaide. ARIA+ is derived by measuring the road distance from a point to the nearest urban centres and localities in five separate population ranges. For more information on how ARIA+ is created see the University of Adelaide website at https://www.adelaide.edu.au/hugo-centre/services/aria

The University of Adelaide supplies ARIA+ to the ABS as a one-kilometre grid that covers all of geographic Australia. Each grid point contains a value representing its relative remoteness, derived using the methodology described in the link above. The resulting average score determines which remoteness category is allocated to each ASGS Statistical Area Level 1 (SA1); these categories are shown in Table 36 below.

Table 36. 2016 Remoteness Area Category Names for Australia and SA1 Average ARIA+ Value[31,32]

Remoteness Area Category	Remoteness Area Name	SA1 Average ARIA+ Value Ranges
0	Major Cities of Australia	0 to 0.2
1	Inner Regional Australia	greater than 0.2 and less than or equal to 2.4
2	Outer Regional Australia	greater than 2.4 and less than or equal to 5.92
3	Remote Australia	greater than 5.92 and less than or equal to 10.53
4	Very Remote Australia	greater than 10.53

Site reports for participating services

Feedback to participants is an essential component of the National Stroke Audit program, with evidence that audit and feedback can influence and change clinical practice.[33] Each participating service receives a hospital stroke service level report highlighting their performance, so that informed decisions can be made to improve patient care and outcomes. These reports show changes over time and allows the services to benchmark their 2021 performance against similar services across Australia for continuous quality improvement purposes.

In addition, all participating services have access to graphical representation of their results and report downloads via their secure site page on the Stroke Foundation Informme website: www.informme.org.au

Supplementary information

In addition to this report, a document with additional information is available on informme www.informme.org.au

The supplement document includes:
- List of auditors from each service.
- Numerators and denominators used for analysis.
- Exclusion criteria used for analysis.
- Reliability record analysis.
- Table of matched data analysis for "year effect".
- Details of questions from the Organisational Survey and Clinical Audit.
- Further detail regarding the Framework and key performance indicators.

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