MONASH University

Stroke FOUNDATION

Stroke Foundation Audits – a 20 year retrospective

July 2019

FOREWORD

On behalf of the Stroke Foundation and our Clinical Council we present the 20-year evaluation of Stroke Foundation's National Audit Program. This report showcases the evolution of stroke treatment and care over the last two decades. It demonstrates the impact the Stroke Foundations' National Audit Program has had in reporting and driving quality improvement in our health services, benefiting thousands of Australians.

This National Stroke Audit Program is the only program of its kind in Australia. It is distinguished by the quality of its data and the large sample size. More than 300 health services have participated and almost 40,000 case notes have been analysed since the Audit Program's inception.

The Acute Services and the Rehabilitation Services Audit Reports - produced in alternate years - are central to the Stroke Foundation's commitment to ensuring all Australians receive evidence-based stroke treatment. The Audit provides a mechanism to monitor health system organisation, stroke services and adherence to the treatment recommended in the National Stroke Clinical Guidelines.

With the support of Government, health services and health professionals, the Audit Program is encouraging quality improvement in stroke services. More Australians are surviving stroke than ever before, and more Australians are accessing evidence-based stroke treatment.

Much has changed over the last two decades with significant advances in stroke care. In this report, we can see the increased availability of thrombolysis (clot dissolving) therapy. In 1999 just 4% of participating hospitals reported providing this treatment but in 2017 this number had increased to 77%. We have also seen a dramatic increase in the number of stroke units in this country. In 1999 there were just 35 dedicated stroke units in Australia admitting 43% of stroke patients. In 2017 there were 89 stroke units, admitting 79% of stroke patients. Stroke unit care has some of the strongest evidence for improved patient outcomes in stroke. Boosting access to evidence-based stroke unit care has been a key area of focus for the Stroke Foundation over the past two decades.

We are proud to say Australian researchers, clinicians and Stroke Foundation have played important roles in the breakthroughs changing the way stroke is treated nationally and internationally. We look forward to seeing how emergency stroke treatments further evolve through future Audit results. We are already seeing the impact of endovascular thrombectomy (clot removal), telehealth technology and new innovations in critical treatment pathways including Australia's first Mobile Stroke Unit (Stroke Ambulance). This activity is being further enhanced by new technology to facilitate communication between paramedics and hospital teams prior to the patient's arrival in hospital. With increased research, we also hope to see similar breakthroughs in rehabilitation interventions over the coming years.

We have come a long way but there is more to do to ensure equity of access to evidence- based stroke treatment and care. The availability of time critical stroke treatment has increased, but faster treatment is required to maximise the benefits to patients. Access to treatment is not equal and regional Australians bear much of the brunt of this inequality.

The Audit Program also highlights the need for greater focus on life after stroke and secondary stroke prevention. Aspects of stroke rehabilitation care in this country have stagnated and improvements to the quality of stroke care in Australian hospitals has been limited.

As with previous advancements in acute stroke treatment, the Stroke Foundation Audit Program will chart the course of improvements in stroke treatment and care for decades to come. It will remain agile and responsive to the latest evidence, while also supporting equity of access to best-practice stroke treatment and care for all Australians. By monitoring various aspects of infrastructure, people and processes related to stroke care we can continue to highlight what is working well and where improvements are needed.

The Audit Program empowers governments, health services, health professionals and the Stroke Foundation to focus efforts and investment where they are needed most. The Audit Program has been central to the development of Stroke Foundation's strategic plan and activities since its inception in 2007.

Stroke Foundation's Audit Program is recognised nationally and internationally for its independence and focus on evidence-based best practice in stroke care. In commending the recommendations contained in this report, we would also like to acknowledge the 1999 Stroke Foundation Board President Peter Mitchell AM and Dr Erin Lalor AM who was the Stroke Foundation Chief Executive Officer from 2002 -2015 for their incredible foresight in establishing the National Audit Program. There are too many contributors over the past two decades to list individually. Stroke Foundation staff, members of our Clinical Council as well those who have overseen the data analysis have been instrumental to ensuring the quality of the stroke audit program and the impact it has made. However, we would also like to make special mention of Professor Dominique Cadillac who has led the data analysis aspect of the audit and Stroke Foundation National Manager Clinical Services Kelvin Hill who has steered the Audit Program and its delivery for many years.

Finally, we would also like to take this opportunity to whole heartedly thank all of the health professionals and health services who have taken part in the Audit over 20 years. It is your time and dedication to improving stroke care that has enabled the delivery of this quality report.

This is your report and we will continue to stand with you to prevent stroke, save lives and enhance recovery.

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Suggested citation

Cadilhac DA, Purvis T, Reyneke M, Dalli L, Kim J, Kilkenny MF. Evaluation of the National Stroke Audit Program: 20-year report. 2019 Jan. Pages 1-109.

Acknowledgments

We acknowledge Dr Sheik Alif for his assistance in populating tables with data for Part A, and Ms Garveeta Sookram for reviewing the report. We also thank the hospital clinicians and patients who contributed data to the audits.

Monash University researchers were commissioned by the Stroke Foundation to write this independent report.

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EXECUTIVE SUMMARY

The aims of the National Stroke Audit Program 20-year report were to:

- Describe changes from 1999-2017 in acute stroke care and outcomes using data from the National Stroke Audit Acute Services (Part A);
- Describe changes from 2008-2018 in rehabilitation stroke care and outcomes using data from the National Stroke Rehabilitation Audit (Part B);
- Estimate the health and economic impact of improving acute stroke management to best practice standards using Acute Audit data (Part C);
- Describe the changes in data monitoring, policy (clinical guidelines) and practice for stroke care over the last 20 years (Part D).

National Stroke Audit Acute Services 1997-2017 (Part A) main findings:

Over this time, the organisation of services for patients with acute stroke has changed, such as in the use of triage protocols in the emergency department, establishment of stroke units, stroke clinical pathways, access to telemedicine and support for staff education. Improvements to the organisation of stroke care in hospitals were seen in both rural and urban hospitals, and were generally consistent across hospital sizes.

A greater proportion of patients with stroke have been treated with evidence-based therapies that are recommended in acute clinical guidelines, particularly in relation to access to stroke unit care, and provision of thrombolysis for eligible patients. However, some patients are not being provided these therapies despite being eligible.

Timely access to allied health, provision of secondary prevention advice for risk factor modification, and processes relating to supporting the patient and carer in the transition from hospital improved over the audits.

National Stroke Audit Rehabilitation Services 2008-2018 (Part B) main findings:

Changes in the quality of stroke care in rehabilitation hospitals from 2008 to 2018 have been limited.

The organisation of rehabilitation services for patients with stroke has changed in some hospitals around features such as resources, workforce and infrastructure. In particular, more hospitals met eight or more elements in the Rehabilitation Stroke Services Framework (2018: 35%, 2014: 14%).

Variability in clinical change was seen across the audits, with adherence to many processes remaining relatively unchanged over the audits. In the areas that did improve, often gaps in care remained. More patients accessed psychologists in 2018 compared to earlier audits, although one in two patients with mood impairment did not access this service in 2018. While the focus on sexuality improved, almost four in five patients missed out on the opportunity to discuss these issues.

There were minimal improvements to the organisation of stroke care and quality of care in rehabilitation hospitals in both public and private hospitals, and this was consistent across hospital sizes.

Economic impact of improving stroke care standards (Part C) main findings:

The estimated benefits to the health of the Australian community from improving the quality of care provided to patients with acute stroke could be achieved at a relatively low cost per disability adjusted life year avoided.

This evidence supports further investment in initiatives to drive quality improvement.

Changes in data monitoring, policy and practice for stroke care (Part D) main findings:

Data from the acute and rehabilitation audits have been used to inform a number of clinical and policy initiatives.

The indicators collected within the acute and rehabilitation audits are based on the current evidence base outlined in clinical guidelines, and promote monitoring the status of Australian hospitals against the Acute Stroke Clinical Care Standard, and Stroke Services Frameworks.

Audit and feedback initiatives using clinical data have been used at local, state and national levels in an effort to improve the quality of care provided to patients with stroke in Australia with the majority occurring in the acute setting, rather than rehabilitation.

Audit data have been used to answer research questions in over ten peer-reviewed publications, and more than 30 conference presentations.

Part A: National Stroke Audit Acute Services 1999–2017

PART A NATIONAL STROKE AUDIT ACUTE SERVICES 1999-2017

1 BACKGROUND

The first national survey of acute hospital services was conducted in 1999 by the Stroke Foundation to provide a snapshot of stroke service provision and attitudes towards interventions for the management of patients with stroke. The original survey was based on a questionnaire used by Ebrahim and Redfern[1] in their survey of British stroke services, and modified according to differences in the two health systems. In 1999, the only national clinical practice guidelines for stroke in Australia were the National Health and Medical Research Council Guidelines for the Prevention of Stroke,[2] with the first national clinical guidelines published in 2003.[3] A subsequent survey to obtain organisational service characteristics was performed in 2004.

The National Stroke Audit program was established as an initiative to facilitate the delivery of evidence-based care for patients with stroke. Since 2007, it has been conducted by the Stroke Foundation biennially in acute hospitals in Australia. The audit program comprises two components: an organisational survey, and a retrospective clinical medical record audit to collect patient level data on processes of care received during the admission and in-hospital outcomes. The original 2007 clinical audit was based on the Royal College of Physicians Sentinel Stroke Audit.[4] Questions for the organisational survey and clinical audit in subsequent years have been mapped to updated clinical guidelines for stroke management[5] and, more recently, the Acute Stroke Services Framework,[6] with ongoing input from the Stroke Foundation and its Clinical Council. The aim of this report was to provide an overview of the changes in stroke service characteristics reported from organisational survey data collected from 1999 to 2017, and to provide a summary of recommended evidence-based care from 2007 to 2017 using data from the clinical medical record audits.

2 METHODS

This study includes cross-sectional data collected from self-reported organisational surveys completed by a clinical representative from Australian hospitals delivering acute stroke care in 1999, 2004, 2007, 2009, 2011, 2013, 2015 and 2017, as well as patient-level data from the clinical audits conducted in 2007, 2009, 2011, 2013, 2015 and 2017 as part of the National Stroke Audit program.

2.1 Sampling methods

The identification of acute hospitals invited to participate in the surveys and clinical audits varied year to year, with eligibility primarily based on stroke admissions (Table 1).

Table 1 Sampling methods for identification of eligible hospitals for each survey and audit

Year	Organisational Survey	Clinical Audit
1999	• National Stroke Foundation identified both public and private hospitals admitting patients with stroke with 40+ beds • Survey posted to nominated staff from each hospital	• Not completed
2004	• Focus was on 'public hospitals with an emergency department' identified through the '2004 Hospital and Health Services Year Book' database • National Stroke Foundation and Australian Stroke Units Network verified eligible hospitals • Private hospitals, children's, women's, mental health, defence force, other specialist hospitals, and very small hospitals were excluded • Survey posted to nominated staff from each hospital	• Not completed

Year	Organisational Survey	Clinical Audit
Introduction of biennial National Stroke Audit Program		
2007	• Hospitals participating in 2004 were initially targeted • Additional eligible hospitals were identified through the Australian Stroke Units Network and Stroke Society of Australasia, with particular focus on hospitals categorised as A or B according to the NSUP model[7] • A small number of private hospitals elected to participate but were not actively recruited	• Similar to recruitment for organisational survey
2009	• A list of all public hospitals admitting patients with stroke was obtained from the Australian Institute of Health and Welfare; each hospital was contacted about participating in the organisational and clinical aspects of the audit program, with focus on category A or B (NSUP model) hospitals • A small number of private hospitals elected to participate but these were not actively recruited	• Similar to recruitment for organisational survey
2011	• All hospitals admitting and managing patients with stroke were eligible to participate, and were identified through previous participation and additional information from state health departments and state-wide stroke clinical networks • Private hospitals known to admit patients with acute stroke were invited to participate	• Similar to recruitment for organisational survey
2013	• All hospitals admitting and managing patients with stroke were eligible to participate, and were identified through previous participation and additional information from state health departments and state-wide stroke clinical networks • Small hospitals with a policy to transfer patients with stroke were excluded • Private hospitals known to admit patients with acute stroke were invited to participate	• Similar to recruitment for organisational survey
2015	• Hospitals admitting at least three patients with acute stroke annually were eligible to participate, and were identified through previous participation in conjunction with clinical leads and state-wide stroke clinical networks • Hospitals with greater than 50 stroke admissions annually completed a long form (data included in this report), and those with less than 50 completed a short form (n=77), with data not included in this report • Private hospitals known to admit patients with acute stroke were invited to participate	• Hospitals admitting greater than 50 patients with stroke per year were targeted • Smaller hospitals were able to participate but were not actively recruited
2017	• Hospitals admitting at least five patients with acute stroke annually were eligible to participate, and were identified through previous participation in conjunction with clinical leads and state-wide stroke clinical networks • Private hospitals known to admit patients with acute stroke were invited to participate	• Hospitals admitting 45 or more patients with stroke per year were targeted • Smaller hospitals were able to participate but were not actively recruited

NSUP: National Stroke Unit Program

For each year, it was standard practice for eligible hospitals to be invited to participate in the data collection, with follow-up emails and phone calls to improve the response rate. Hospitals choosing not to participate in the clinical audit were still encouraged to complete the organisational survey.

It was recognised that service characteristics in hospitals admitting less than 40-50 patients with stroke annually potentially differed from those treating larger volumes. Therefore, in later years, the focus of recruitment was primarily on hospitals admitting 40 (or 50) or more patients with stroke annually. Private hospitals were not actively recruited in the same way that public facilities were, however, they were not discouraged.

2.2 Data collection

In 1999 and 2004, all self-reported organisational survey data (completed by a clinical representative considered appropriate to describe stroke care within their hospital) were entered into an Access (Microsoft 97) database and verified. For the clinical medical record audit included from 2007 onwards, clinicians from participating hospitals audited up to 40 consecutive medical records of patients with stroke (based on ICD-10 codes) admitted from June to December in the year prior to the respective audit period. From 2007 to 2013, clinicians at each hospital entered both survey data and clinical audit data via a web-based data entry tool, which included comprehensive field notes embedded into the system and programmed logic checks. From 2015, all data were collected using the integrated data collection system, the Australian Stroke Data Tool (AuSDaT). Hospitals were assigned an individual hospital code and no patient-identifying data were collected, ensuring that all data were de-identified.

2.3 Data analyses

Given the focus on recruitment of public hospitals for participation in the data collection, only public hospitals were included in these analyses. Few private hospitals contributed organisational data after 2007 (1999: 57; 2007: 10; 2009: 4; 2011: 4; 2013: 5; 2015: 6; 2017: 5). Hospitals with less than 40 stroke admissions per year were excluded in an attempt to keep the survey and audit data comparable.

For organisational survey data, specific questions and response options differed across the periods, particularly from 1999/2004 to 2007-2017. Therefore, survey data from 1999, 2004, 2007, 2009, 2011, 2013, 2015 and 2017 were mapped for consistency to enable reliable comparisons. Relevant service characteristics and resources have been described over each survey period. Differences in available services and resources over time based on geographical location and annual stroke admissions (volume) were described for the organisational survey data between 2007 and 2017. Hospitals in metropolitan or large regional areas with a local governance area of greater than or equal to 25,000 were described as 'urban', while 'rural' hospitals were considered to be in locations with less than 25,000 people.[8] Hospitals reporting 40-99 annual stroke admissions were considered small volume hospitals; hospitals with 100-349 annual stroke admissions were considered medium volume hospitals; and those with 350 or more annual stroke admissions were considered large volume hospitals. For select organisational survey data, random effects logistic regression was performed, with clustering for hospital, to determine changes over the audit periods. Odds ratios (OR) and 95% confidence intervals (CI) are provided. Chi square was performed to assess differences in available services and resources in the recent audit/periods based on geographical location and stroke admissions.

For clinical audit data, patient care and in-hospital outcomes from 2007, 2009, 2011, 2013, 2015 and 2017 were again mapped for consistency to enable reliable comparisons. Only valid responses were included for questions relating to impairments, not 'documented/unknown' responses were assumed to be negative and included in the denominator for processes of care analyses. For quality of care processes, descriptive statistics were used to report the frequency and percentages for categorical data, and median was used for numerical data. Random effects logistic regression was performed and reported as odds ratio (OR) with 95% confidence intervals (CI) to investigate the association between specific clinical processes and differences over audit periods, with clustering for the hospital. All time-related variables were calculated from Emergency Department (ED) presentation unless otherwise stated. Processes of care data were further stratified by geographical location and stroke admission volume per year (as described in above paragraph for survey data), using hospitals that participated in the audit in the early (2007 and/or 2009), mid (2011 and/or 2013), and late (2015 and/or 2017) periods (n=86).

A matched hospital sample was used to examine differences in patient outcomes over time (including length of stay (LOS), death or disability (modified Rankin Scale [mRS]: 3-6[9]), and discharge destination). Data from 51 hospitals that completed the clinical audit in each period were included. Results were adjusted for factors known to be associated with outcome: age, sex, pre-stroke function, prior history of stroke, stroke type, severity factors such as inability to walk, arm weakness and speech impairment on admission and incontinence within 72 hours,[10] and geographic location. For LOS, a median regression model with bootstrap estimated standard errors was used, with random effects logistic regression for binary outcomes such as death, discharge to usual residence and dischagre to inpatient rehabilitation. A p-value<0.05 was considered to be statistically significant.

Throughout the tables in this report, the symbol '–' is used to indicate where questions were not asked in a particular year or were deemed incomparable. The sum of individual proportions may not add to 100% due to rounding. Denominators reported in column headings of tables may not be applicable to all processes reported within as many relate to only those eligible to receive the process.

The same researchers involved from the outset of the audit program analysed all data using Stata SE 15.0.[11]

3 RESULTS FROM THE ORGANISATIONAL SURVEYS ACROSS THE YEARS

3.1 Organisational Survey: Results by year (1999 to 2017)

The following section includes data from all public hospitals responding to the organisational survey in any period, and provides a descriptive overview of changes in adherence from 1999 to 2017.

3.1.1 Characteristics of the hospitals providing stroke care

The public hospitals participating in the organisational survey from 1999 to 2017 are outlined in Table 2.

Table 2 Summary of public hospitals included in the organisational survey analyses (1999-2017)

	1999 N=163	2004 N=261	2007 N=244	2009 N=202	2011 N=184	2013 N=172	2015 N=112	2017 N=122
< 40 admissions[1]	30	83	119	90	75	57	5	10
≥ 40 admissions[1]	133[2]	178[2]	125	112	109	115	107	112

[1]stroke admissions in previous year; [2]includes hospitals that did not report admission numbers

Table 3 depicts the median number of patients with stroke in hospital on the day of survey completion as well as the median number admitted in the previous year. Although hospitals with less than 40 annual stroke admissions were excluded, the median number of admissions reported in 1999 and 2004 was potentially influenced by the sampling method (Table 1) and responses received (Table 2).

Table 3 Patients with stroke managed at hospitals (1999-2017)

	1999 N=133	2004 N=178	2007 N=125	2009 N=112	2011 N=109	2013 N=115	2015 N=107	2017 N=112
Stroke patients in hospital[1] - median (Q1, Q3)	1 (0, 4)[2]	-	5 (2, 10)	4 (2, 10)	5 (2, 8)	4 (2, 9)	4 (2, 8)	4 (2, 8)
Stroke patients admitted last year - median (Q1, Q3)	300 (122, 400)[3]	220 (100, 300)[3]	150 (71, 290)	180 (81, 300)	158 (85, 300)	155 (75, 300)	191 (100, 316)	204 (104, 342)

Q1: 1st quartile; Q3: 3rd quartile; [1]on day of survey; [2]question asked as 'stroke patients under care today'; [3]In 1999 and 2004, not all hospitals provided admission numbers.

3.1.2 Rapid triage, assessment and investigations

Overall, there has been an increase in the majority of aspects of service related to rapid triage in the ED, assessment and investigations from 1999 to 2017, but particularly from 2007 to 2017 (Table 4). An increasing number of hospitals used ED protocol for rapid triage: 49% in 2007, 93% in 2017 (OR 1.5, 95% CI 1.3, 1.6, p<0.001). Onsite and offsite access to brain imaging via CT (computerised tomography) or MRI (magnetic resonance imaging) was variable in 1999 and 2004. Just over 60% of the hospitals had access to CT within 24 hours in 1999, compared to 99% accessing CT within 3 hours in 2017. Similarly, in 1999, only 5% of hospitals had access to MRI in 24 hours, compared to 77% in 2017.

Table 4 Changes in ED triage, assessment and diagnostic investigations (1999-2017)

	1999 N=133 n (%)	2004 N=178 n (%)	2007 N=125 n (%)	2009 N=112 n (%)	2011 N=109 n (%)	2013 N=115 n (%)	2015 N=107 n (%)	2017 N=112 n (%)
ED protocols for rapid triage	-	89 (50)	61 (49)	60 (54)	80 (73)	96 (83)	95 (89)	104 (93)
Access to carotid Doppler	-	-	112 (90)	105 (94)	105 (96)	112 (97)	-	-
Access to carotid Doppler within 24 hours	-	-	45 (36)	86 (77)	94 (86)	89 (77)	92 (86)	103 (92)
Brain Imaging								
Access to CT[1]	121 (91)	167 (94)	119 (95)	109 (97)	109 (100)	114 (99)	-	-
Access to CT within 24 hours	81 (61)	-	115 (92)	108 (96)	107 (98)	114 (99)	103 (96)[2]	111 (99)[2]
Access to MRI[1]	72 (54)	134 (75)	91 (73)	85 (76)	88 (81)	89 (77)	-	-
Access to MRI within 24 hours	6 (5)	-	63 (50)	64 (57)	71 (65)	65 (57)	77 (72)	86 (77)

ED: Emergency Department; CT: computerised tomography; MRI: magnetic resonance imaging; [1]onsite or offsite; [2]within 3 hours

3.1.3 Reperfusion treatment with intravenous thrombolysis and acute services

There was an overall increase in hospitals providing intravenous thrombolysis over the last two decades, from 4% in 1999 to 77% in 2017 (Figure 1). From 2009 to 2017, the number of hospitals who offered this service 24 hours a day, seven days a week (24/7) also increased (Table 5). The proportion of hospitals that had access to high dependency units (HDUs) and intensive care units (ICUs) also increased from 2004 (71%) to 2017 (97%), however, no significant change was evident from 2007 to 2017 (OR 1.03, 95% CI 0.77, 1.4).

Table 5 Changes in availability of reperfusion treatment and acute services (1999-2017)

	1999 N=133 n (%)	2004 N=178 n (%)	2007 N=125 n (%)	2009 N=112 n (%)	2011 N=109 n (%)	2013 N=115 n (%)	2015 N=107 n (%)	2017 N=112 n (%)
Hospital provides intravenous tPA for acute stroke	5 (4)[1]	39 (22)[1]	46 (37)	49 (44)	60 (55)	77 (67)	80 (75)	86 (77)
Offers intravenous tPA 24/7	-	-	-	38 (34)	51 (47)	65 (57)	72 (67)	77 (69)
Access to HDU/ICU	-	127 (71)	105 (84)	103 (92)	103 (95)	111 (97)	101 (94)	109 (97)

tPA: thrombolysis; 24/7: 24 hours a day, 7 days a week; HDU: high dependency unit; ICU: intensive care unit; [1]not directly asked, 1999 question was 'is thrombolytic therapy used' & 2004 question 'hospitals with protocols & guidelines for thrombolysis' was used as surrogate

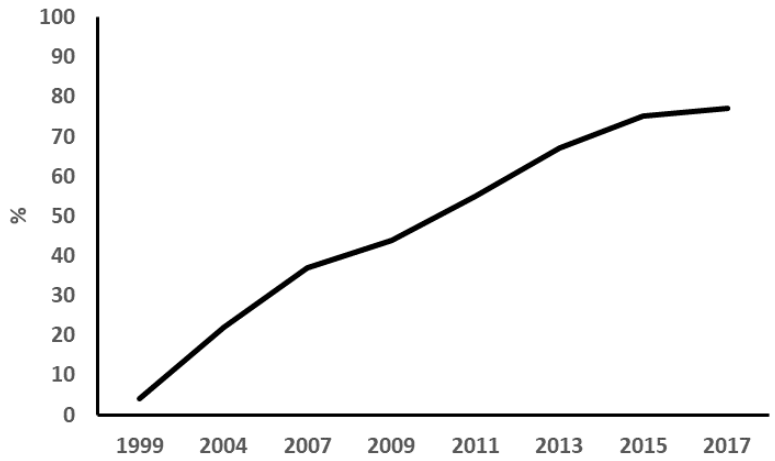


Figure 1 Proportion of public hospitals offering intravenous thrombolysis for acute ischaemic stroke (1999-2017)

3.1.4 Stroke unit access

The proportion of hospitals with a stroke unit increased from 26% in 1999 to 79% in 2017 (Table 6 and Figure 2). Although the question and response options changed over time, of those hospitals with a dedicated stroke unit, the number likely to directly admit patients to the stroke unit increased over time (1999: 43%, 2017: 79%), with the exception of 2007 (Figure 2).

Table 6 Stroke unit access (1999-2017)

	1999 N=133 n (%)	2004 N=178 n (%)	2007 N=125 n (%)	2009 N=112 n (%)	2011 N=109 n (%)	2013 N=115 n (%)	2015 N=107 n (%)	2017 N=112 n (%)
Hospital has SU	35 (26)	48 (27)	53 (42)	65 (58)	70 (64)	86 (75)	83 (78)	89 (79)
Likely to admit directly to SU if SU hospital[1]	15 (43)	26 (54)	12 (23)	53 (82)	56 (80)	79 (92)	63 (76)	70 (79)

SU: stroke unit; [1]questions and response options changed over time, including some open text and other categorical responses

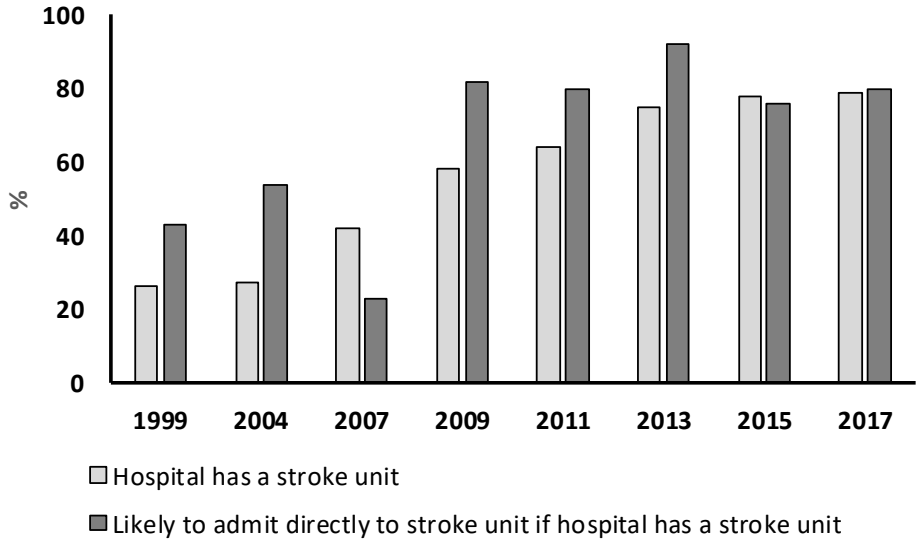


Figure 2 Changes in stroke unit access over time (1999-2017)

3.1.5 Acute stroke team

Overall, there was greater access to allied health specialties for patients with stroke in 2017 compared to 1999 (Table 7). This included physiotherapy, occupational therapy, speech pathology, dietetics and social work. Access to psychology services remained poor over all survey periods (1999: clinical psychology 20%; 2017: clinical or neuropsychology 37%). Specialist nurses were available in more hospitals in 2017 (69%) than in 2004 (22%). Although the related question changed over the years, at least two in three hospitals reported having a medical consultant in the team that managed patients with stroke in 1999 and 2004. Comparisons from 2009 to 2017 demonstrated significant improvements in access to:

- consultant physicians (OR 1.3, 95% CI 1.2, 1.4),
- specialist nurses (OR 1.2, 95% CI 1.1, 1.3), and
- psychologists (OR 1.2, 95% CI 1.1, 1.3).

From 2009, the majority of hospitals had access to physiotherapy, occupational therapy, speech pathology, social work and dietetics.

Table 7 Interdisciplinary team profiles (1999-2017)

	1999 N=133 n (%)	2004 N=178 n (%)	2007 N=125 n (%)	2009 N=112 n (%)	2011 N=109 n (%)	2013 N=115 n (%)	2015 N=107 n (%)	2017 N=112 n (%)
Dedicated MDT with specialist interest in stroke	-	-	-	76 (68)	80 (73)	100 (87)	95 (89)	101 (90)
Consultant physician with specialist knowledge[1]	94 (71)[2]	115 (65)[2]	-	56 (50)	64 (59)	79 (69)	68 (64)	80 (71)
Specialist nurse[3]	-	39 (22)	-	73 (65)	65 (60)	79 (69)	73 (68)	77 (69)
Occupational therapist	117 (88)	141 (79)	-	109 (97)	108 (99)	115 (100)	107 (100)	112 (100)
Physiotherapist	129 (97)	145 (81)	-	112 (100)	109 (100)	115 (100)	107 (100)	112 (100)
Speech pathologist	120 (90)	140 (79)	-	111 (99)	108 (99)	115 (100)	107 (100)	112 (100)
Dietitian	105 (79)	134 (75)	-	109 (97)	106 (97)	113 (98)	107 (100)	112 (100)
Social worker	111 (83)	135 (76)	-	110 (98)	103 (94)	112 (97)	105 (98)	111 (99)
Psychologist[4]	26 (20)	25 (14)	-	32 (29)	20 (18)	31 (27)	36 (33)	41 (37)

MDT: multidisciplinary team; [1]who is formally recognised as having principle responsibility for stroke; [2]question in 1999/2004 includes 'team managing patients with stroke includes a consultant'; [3]may include combination of specialist nurse, stroke liaison nurse, clinical nurse consultant, clinical nurse specialist, nurse practitioner or stroke nurse educator in different years; [4]1999-2011 referred to clinical psychologist, with 2013-2017 including clinical or neuropsychologist

3.1.6 Team communication and ongoing professional development education

In 2017, 91% of hospitals reported having a weekly team meeting, in contrast to just over 50% in 1999 and 2004 (Table 8). However, this practice had not changed significantly from 2007 to 2017 (OR 1.1, 95% CI 0.96, 1.2). Clinical pathways were being used in more hospitals in 2017 (85%), compared to 2007 (67%) (OR 1.2, 95% CI 1.1, 1.3). Ongoing staff education also greatly increased, with only 39% of hospitals reporting that they offered this regularly in 1999, compared to 87% in 2017 (Figure 3).

Table 8 Changes in team communication and ongoing education (1999-2017)

	1999 N=133 n (%)	2004 N=178 n (%)	2007 N=125 n (%)	2009 N=112 n (%)	2011 N=109 n (%)	2013 N=115 n (%)	2015 N=107 n (%)	2017 N=112 n (%)
Weekly team meeting	71 (53)	102 (57)	112 (90)	98 (88)	100 (92)	111 (97)	99 (93)	102 (91)
Clinical care pathway for managing stroke	-	-	84 (67)	76 (68)	72 (66)	91 (79)	88 (82)	95 (85)
Ongoing staff education	52 (39)	85 (48)	92 (74)	67 (60)	81 (74)	99 (86)	92 (86)	97 (87)

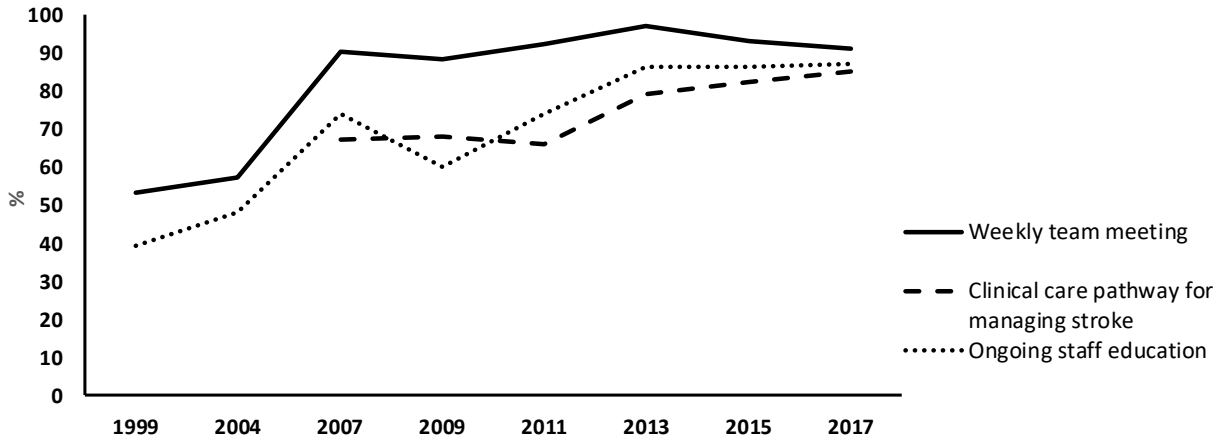


Figure 3 Changes in team communication and ongoing professional development education (1999-2017)

In 1999, one in five hospitals (20%) reported having a local stroke register listing all new referrals admitted with a diagnosis of stroke. This increased to over 60% in 2013 (question not asked in 2015/2017).

3.1.7 Discharge processes

Changes in discharge processes were also evident over time (Table 9). Almost all hospitals reported meeting with patients and/or family regarding care in 2017, up from 70% in 2004, with similar changes evident in hospitals that provide information to the patient and family (1999: 47%; 2004: 56%; 2017: 96%). Variability existed in the proportion of hospitals that reported providing patients with a discharge care plan. Fewer hospitals reported using an early supported discharge service in more recent years compared to earlier (2017: 11%; 2007: 22%; 2004: 35%), although the specifics of this question changed. Over 80% of hospitals had access to ongoing rehabilitation (inpatient, outpatient or community) in all years, with no difference when comparing 2017 to 2007 (OR 0.98, 95% CI 0.82, 1.2).

Table 9 Changes in discharge processes (1999-2017)

	1999 N=133 n (%)	2004 N=178 n (%)	2007 N=125 n (%)	2009 N=112 n (%)	2011 N=109 n (%)	2013 N=115 n (%)	2015 N=107 n (%)	2017 N=112 n (%)
Meet with patient/family regarding care	-	125 (70)	95 (76)	85 (76)	84 (77)	98 (85)	105 (98)[1]	109 (97)[1]
Provide patient/family information	63 (47)	99 (56)	101 (81)[2]	89 (79)[2]	92 (84)[2]	105 (91)[2]	100 (93)	107 (96)
Provide patient with discharge plan	-	-	84 (67)	65 (58)	69 (63)	69 (60)	44 (41)	65 (58)
Stroke specific early supported discharge service	-	62 (35)[3]	28 (22)	20 (18)	25 (23)	31 (27)	9 (8)	12 (11)
Ongoing rehabilitation[4]	-	151 (85)	121 (97)	111 (99)	107 (98)	112 (97)	103 (96)	111 (99)

[1]routinely involve/inform patient/family in clinical management; [2]specific literature on stroke; [3]generic service; [4]inpatient, outpatient/home-based rehabilitation in 2004, onsite/offsite/community-based in 2007-2013 and inpatient/outpatient/day hospital in 2015 & 2017

3.1.8 Access to telehealth

Variability existed in the use of telehealth services. Use of telehealth for professional development has been used consistently and increased to 90% in 2017 from 66% in 2004 (Table 10). Improvements from 2007 to 2017 were also evident (OR 1.2, 95% CI 1.1, 1.3). In recent years, about half of the hospitals reported having *used* telehealth for clinical support 'within the last 6 months'. This is difficult to compare directly to earlier years, where hospitals reported having *access to* telehealth for clinical support.

Table 10 Changes in access to telehealth facilities (1999-2017)

	1999 N=133 n (%)	2004 N=178 n (%)	2007 N=125 n (%)	2009 N=112 n (%)	2011 N=109 n (%)	2013 N=115 n (%)	2015 N=107 n (%)	2017 N=112 n (%)
Telehealth for clinical support	-	98 (55)	76 (61)	64 (57)	70 (64)	77 (67)	47 (44)[1]	58 (52)[1]
Telehealth for professional development	-	118 (66)	91 (73)	81 (72)	85 (78)	97 (84)	97 (91)	101 (90)

[1]used within the last 6 months

3.1.9 Services for patients with transient ischaemic attack (TIA)

In 1999, only 8% of hospitals reported having a TIA/stroke rapid outpatient assessment clinic, whereas in 2017, half of the hospitals either admitted all TIA patients, or had an assessment clinic where these patients could be seen within 48 hours (Table 11). Although not collected in the early surveys, the proportion of hospitals that used defined processes for assessing TIA patients increased from 56% in 2009 to 82% in 2017 (OR 1.3, 95% CI 1.2, 1.5).

Table 11 Changes in access to services for patients with transient ischaemic attack (1999-2017)

	1999 N=133 n (%)	2004 N=178 n (%)	2007 N=125 n (%)	2009 N=112 n (%)	2011 N=109 n (%)	2013 N=115 n (%)	2015 N=107 n (%)	2017 N=112 n (%)
Defined and documented processes for assessing patients with TIA	-	-	-	63 (56)	72 (66)	92 (80)	79 (74)	92 (82)
Presence of TIA/stroke rapid outpatient assessment clinic	10 (8)	31 (17)	25 (20)	50 (45)[1]	51 (47)[1]	63 (55)[1]	51 (48)[2]	57 (51)[2]

TIA: transient ischaemic attack; [1]admit all TIAs or have TIA/stroke rapid outpatient assessment clinic; [2]admit all TIAs or rapid access within 48 hours for hospitals who do not admit all patients with TIA

3.2 Organisational Survey: Urban versus rural comparisons (2007, 2011 and 2017)

The following section provides a descriptive overview of changes in adherence in all urban and rural public hospitals that completed the organisational survey in 2007, 2011 and 2017.

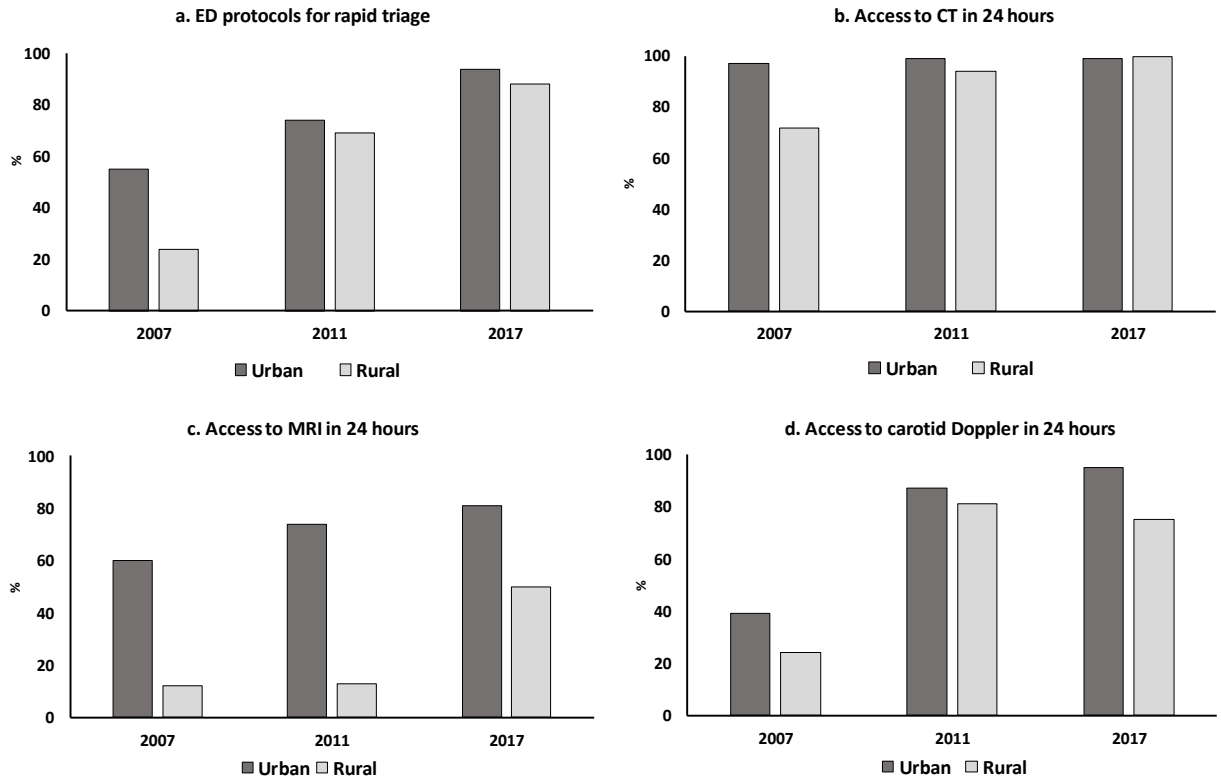
3.2.1 Rapid triage, assessment and diagnostic investigations

Changes in adherence to aspects of care related to rapid triage in the ED, assessment and diagnostic investigations in both urban and rural hospitals are shown in Table 12. From 2007 to 2017, there was an increase in the proportion of hospitals in both urban and rural locations that reported using ED protocols for rapid triage. Access to CT within 24 hours (within 3 hours in 2017) increased over time in rural settings and was at parity with urban hospitals in 2017 (Figure 4b). Although in 2017 a disparity still existed in access to MRI within 24 hours based on geographic region, improvement was evident in rural locations over time (Figure 4c).

Table 12 Changes in access to rapid triage and diagnostic investigations by geographic region (2007, 2011, 2017)

	Urban			Rural		
	2007 N=100 n (%)	2011 N=93 n (%)	2017 N=96 n (%)	2007 N=25 n (%)	2011 N=16 n (%)	2017 N=16 n (%)
ED protocols for rapid triage	55 (55)	69 (74)	90 (94)	6 (24)	11 (69)	14 (88)
Access to carotid Doppler within 24 hours	39 (39)	81 (87)	91 (95)	6 (24)	13 (81)	12 (75)
Brain imaging						
Access to CT within 24 hours	97 (97)	92 (99)	95 (99)[1]	18 (72)	15 (94)	16 (100)[1]
Access to MRI within 24 hours	60 (60)	69 (74)	78 (81)	3 (12)	2 (13)	8 (50)

ED: Emergency Department; CT: computerised tomography; MRI: magnetic resonance imaging; [1]within 3 hours



ED: Emergency Department; CT: computerised tomography; MRI: magnetic resonance imaging

Figure 4 Changes in access to rapid triage and investigations by geographic region (2007, 2011, 2017)

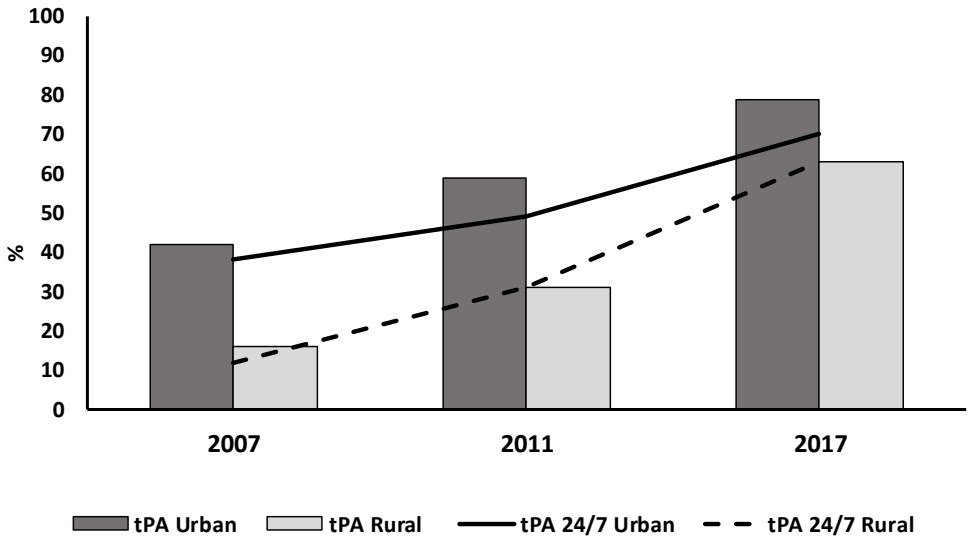
3.2.2 Reperfusion treatment with intravenous thrombolysis

Access to intravenous thrombolysis increased in rural and urban regions from 2007 to 2017 (Table 13 and Figure 5), with a similar increase in the proportion of hospitals offering intravenous thrombolysis 24/7 in urban hospitals. In urban hospitals in 2007, access to high dependency or intensive care units was already above 90%, with only a small increase possible. However, with the poorer access in rural regions, a large increase was found from 2007 to 2017 (Table 13).

Table 13 Changes in access to reperfusion services by geographic region (2007, 2011, 2017)

	Urban			Rural		
	2007 N=100 n (%)	2011 N=93 n (%)	2017 N=96 n (%)	2007 N=25 n (%)	2011 N=16 n (%)	2017 N=16 n (%)
Hospital provides intravenous tPA for acute stroke	42 (42)	55 (59)	76 (79)	4 (16)	5 (31)	10 (63)
Offers intravenous tPA 24/7	36 (38)[1]	46 (49)	67 (70)	2 (12)[1]	5 (31)	10 (63)
Access to HDU/ICU	91 (91)	90 (97)	94 (98)	14 (56)	13 (81)	15 (94)

tPA: thrombolysis; 24/7: 24 hours a day, 7 days a week; HDU: high dependency unit; ICU: intensive care unit; [1]response obtained from 2009 as question not asked in 2007



tPA: intravenous thrombolysis; 24/7: 24 hours a day, 7 days a week

Figure 5 Changes in access to intravenous thrombolysis by geographic region (2007, 2011, 2017)

3.2.3 Stroke unit access

Access to stroke units was greater in urban compared to rural regions across all audits, with larger increases in urban areas evident from 2007 to 2017 (Figure 6). Reports of direct admission to the stroke unit in rural regions were potentially influenced by the small number of stroke units available (Table 14).

Table 14 Changes in stroke unit access by geographic region (2007, 2011, 2017)

	Urban			Rural		
	2007 N=100 n (%)	2011 N=93 n (%)	2017 N=96 n (%)	2007 N=25 n (%)	2011 N=16 n (%)	2017 N=16 n (%)
Hospital has SU	50 (50)	67 (72)	85 (89)	3 (12)	3 (19)	4 (25)
Admit to SU if SU hospital	11 (22)	54 (81)	69 (81)	1 (33)	2 (67)	1 (25)

SU: stroke unit

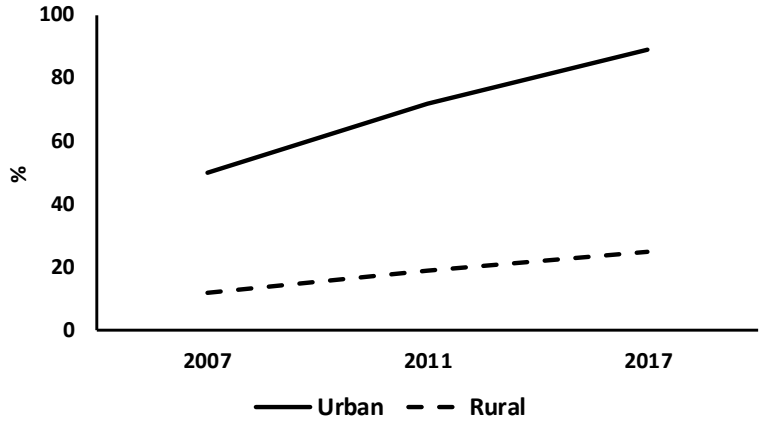


Figure 6 Changes in access to stroke units by geographic region (2007, 2011, 2017)

3.2.4 Access to telehealth

Direct comparisons of telehealth being used for clinical support were difficult due to changes in the wording of the question. Numbers are small so comparisons are not significant, nevertheless, it appears that this service was being used more commonly in rural hospitals in the recent audit (Table 15).

Table 15 Changes in access to telehealth services by geographic region (2007, 2011, 2017)

	Urban			Rural		
	2007 N=100 n (%)	2011 N=93 n (%)	2017 N=96 n (%)	2007 N=25 n (%)	2011 N=16 n (%)	2017 N=16 n (%)
Telehealth for clinical support	59 (59)	60 (65)	47 (49)[1]	17 (68)	10 (63)	11 (69)[1]
Telehealth for professional development	74 (74)	73 (79)	85 (89)	17 (68)	12 (75)	16 (100)

[1]within the last 6 months

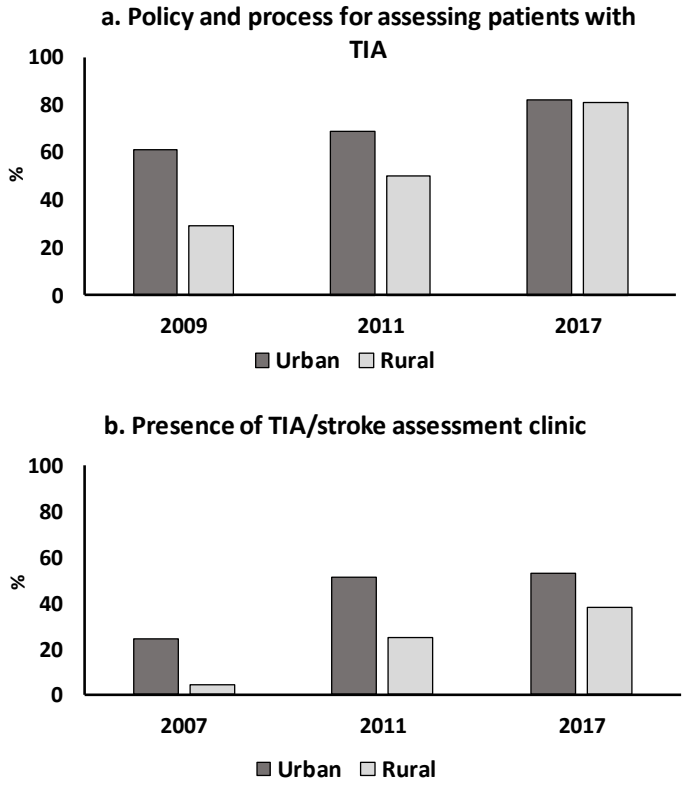
3.2.5 Services for patients with transient ischaemic attack

Greater access to TIA/stroke rapid outpatient assessment clinics was evident from 2007 to 2017 in rural and urban locations (Table 16 and Figure 7a). The reported use of policies and clinical pathways for assessing patients with TIA in rural hospitals was comparable to urban hospitals in the most recent (Figure 7b).

Table 16 Changes in access to services for patients with transient ischaemic attack by geographic region (2007, 2011, 2017)

	Urban			Rural		
	2007 N=100 n (%)	2011 N=93 n (%)	2017 N=96 n (%)	2007 N=25 n (%)	2011 N=16 n (%)	2017 N=16 n (%)
Defined and documented process, policy or clinical pathway for assessing patients with TIA	58 (61)[1]	64 (69)	79 (82)	5 (29)[1]	8 (50)	13 (81)
Presence of TIA/stroke rapid outpatient assessment clinic	24 (24)[2]	47 (51)[3]	51 (53)[4]	1 (4)[2]	4 (25)[3]	6 (38)[4]

TIA: transient ischaemic attack; [1]response obtained from 2009 survey; [2]all hospitals; [3]admit all TIAs or have TIA/stroke rapid outpatient clinic; [4]admit all TIAs or rapid access within 48 hours for hospitals who do not admit all patients with TIA



TIA: transient ischaemic attack

Figure 7 Changes in access to services for patients with transient ischaemic attack by geographic region (2007, 2011, 2017)

3.3 Organisational Survey: Comparisons by annual stroke admission volume (2007, 2011 and 2017)

The following section includes data from all public hospitals responding to the organisational survey in the national audit in 2007, 2011 and 2017. A descriptive overview of changes in adherence by volume of stroke admissions per year (small:<100; medium:100-349; large: 350+ annual stroke admissions) is provided.

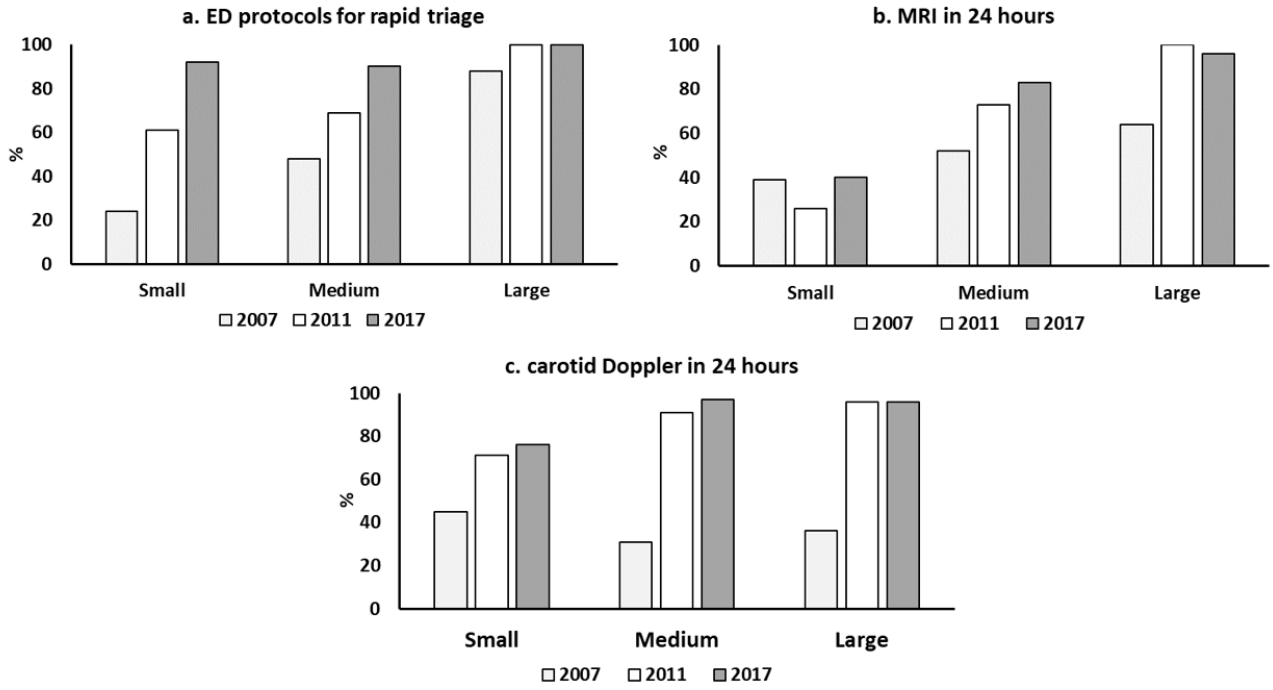
3.3.1 Rapid triage, assessment and investigations

Table 17 and Figure 8a-c depict changes in access to aspects related to triage and diagnostic investigations in 2007, 2011 and 2017. An increase in the proportion of hospitals reporting ED protocols for rapid triage was evident from 2007 to 2017, regardless of the volume, with access in 2017 greater than 90% for all hospitals (Figure 8a). Timely access to CT scans was almost universal for all hospitals in 2017. For small volume hospitals, access to MRI within 24 hours did not change over time. However, more medium and large volume hospitals reported timely access to MRI in 2017 compared to earlier periods (Figure 8b).

Table 17 Changes in access to rapid triage and diagnostic investigations by hospital volume (2007, 2011, 2017)

Stroke volume	Small (<100 admissions)			Medium (100-349 admissions)			Large (350+ admissions)		
	2007 N=38 n (%)	2011 N=31 n (%)	2017 N=25 n (%)	2007 N=62 n (%)	2011 N=55 n (%)	2017 N=60 n (%)	2007 N=25 n (%)	2011 N=23 n (%)	2017 N=27 n (%)
ED protocols for rapid triage	9 (24)	19 (61)	23 (92)	30 (48)	38 (69)	54 (90)	22 (88)	23 (100)	27 (100)
Access to carotid Doppler in 24 hours	17 (45)	22 (71)	19 (76)	19 (31)	50 (91)	58 (97)	9 (36)	22 (96)	26 (96)
Brain Imaging									
Access to CT within 24 hours	31 (82)	30 (97)	25 (100)[1]	59 (95)	54 (98)	59 (98)[1]	25 (100)	23 (100)	27 (100)[1]
Access to MRI within 24 hours	15 (39)	8 (26)	10 (40)	32 (52)	40 (73)	50 (83)	16 (64)	23 (100)	26 (96)

ED: Emergency Department; CT: computerised tomography; MRI: magnetic resonance imaging; [1]within 3 hours



ED: Emergency Department; MRI: magnetic resonance imaging; Small: <100 annual stroke admissions; Medium: 100-349; Large: 350+

Figure 8 Changes in access to rapid transfer and diagnostic investigations by hospital volume (2007, 2011, 2017)

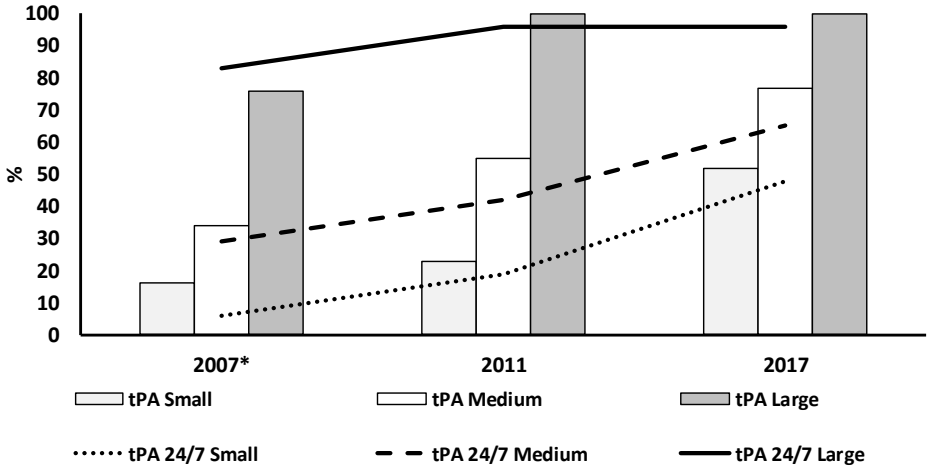
3.3.2 Reperfusion treatment with intravenous thrombolysis

The proportion of hospitals, regardless of volume, offering intravenous thrombolysis increased from 2007 to 2017, with all hospitals with 350+ admissions providing this service in 2017 (Figure 9). Four in five larger volume hospitals reportedly offered intravenous thrombolysis 24/7 in 2009, and this increased to 96% in 2017 (Table 18). A larger proportion of small and medium volume hospitals were also able to provide thrombolysis 24/7 in 2017 compared to earlier periods.

Table 18 Changes in access to reperfusion services by hospital volume (2007, 2011, 2017)

Stroke volume	Small (<100 admissions)			Medium (100-349 admissions)			Large (350+ admissions)		
	2007	2011	2017	2007	2011	2017	2007	2011	2017
	N=38	N=31	N=25	N=62	N=55	N=60	N=25	N=23	N=27
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Offers intravenous tPA	6 (16)	7 (23)	13 (52)	21 (34)	30 (55)	46 (77)	19 (76)	23 (100)	27 (100)
Offers intravenous tPA 24/7	2 (6)[1]	6 (19)	12 (48)	17 (29)[1]	23 (42)	39 (65)	19 (83)[1]	22 (96)	26 (96)
Access to HDU/ICU	25 (66)	26 (84)	22 (88)	55 (89)	54 (98)	60 (100)	25 (100)	23 (100)	27 (100)

tPA: thrombolysis; 24/7: 24 hours a day, 7 days a week; HDU: high dependency unit; ICU: intensive care unit; [1]response obtained from 2009 survey



tPA: intravenous thrombolysis; 24/7: 24 hours a day, 7 days a week; Small: <100 annual stroke admissions; Medium: 100-349; Large: 350+; *data from 2009 used for tPA 24/7

Figure 9 Changes in access to intravenous thrombolysis by hospital volume (2007, 2011, 2017)

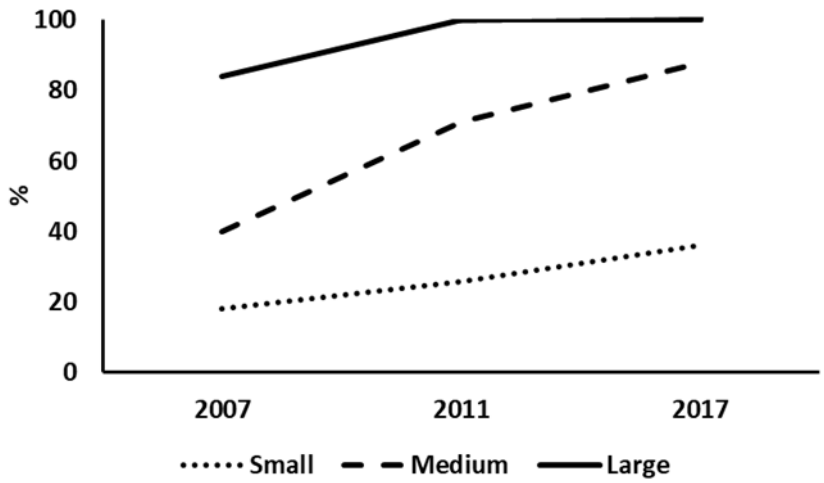
3.3.3 Stroke unit access

Greater increases in stroke unit access were evident in all volume hospitals from 2007 to 2017 (Table 19 and Figure 10). All hospitals with 350 or more stroke admissions per year had a stroke unit in the 2017 audit. There was variation over time in all volume hospitals that reported the ability to directly admit their patients to the stroke unit.

Table 19 Changes in access to stroke units by hospital volume (2007, 2011, 2017)

Stroke volume	Small (<100 admissions)			Medium (100-349 admissions)			Large (350+ admissions)		
	2007	2011	2017	2007	2011	2017	2007	2011	2017
	N=38	N=31	N=25	N=62	N=55	N=60	N=25	N=23	N=27
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Hospital has a SU	7 (18)	8 (26)	9 (36)	25 (40)	39 (71)	53 (88)	21 (84)	23 (100)	27 (100)
Admit to SU if SU hospital	2 (29)	4 (50)	2 (22)	4 (16)	31 (79)	44 (83)	6 (29)	21 (91)	24 (89)

SU: stroke unit



Small: <100 annual stroke admissions; Medium: 100-349; Large: 350+

Figure 10 Changes in access to stroke units by hospital volume (2007, 2011, 2017)

3.3.4 Access to telehealth

No significant change in the proportion of any volume hospitals using telehealth for clinical support was evident between 2007 and 2011. In 2017, approximately half of the hospitals had used telehealth for clinical support in the last 6 months (small: 56%; medium: 47%; large: 60%). More small volume hospitals reported using telehealth for professional development in 2017 compared to earlier time periods (Table 20).

Table 20 Changes in access to telehealth facilities by hospital volume (2007, 2011, 2017)

Stroke volume	Small (<100 admissions)			Medium (100-349 admissions)			Large (350+ admissions)		
	2007 N=38 n (%)	2011 N=31 n (%)	2017 N=25 n (%)	2007 N=62 n (%)	2011 N=55 n (%)	2017 N=60 n (%)	2007 N=25 n (%)	2011 N=23 n (%)	2017 N=27 n (%)
Telehealth for clinical support	24 (63)	19 (61)	14 (56)[1]	40 (65)	35 (64)	28 (47)[1]	12 (48)	16 (70)	16 (60)[1]
Telehealth for professional development	24 (63)	23 (74)	25 (100)	50 (81)	42 (77)	52 (87)	17 (68)	20 (87)	24 (89)

[1]in the last 6 months

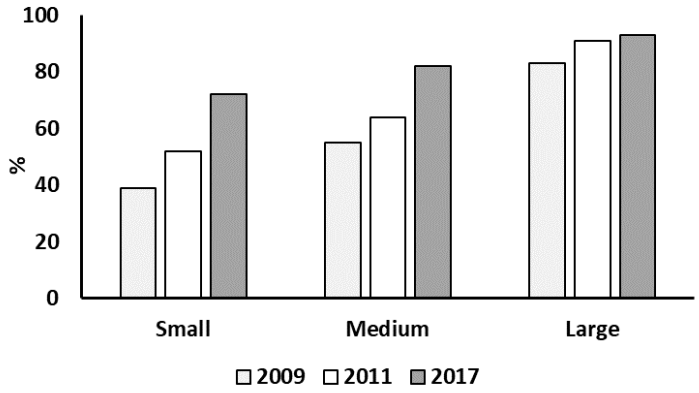
3.3.5 Services for patients with transient ischaemic attack

The reported use of policies and processes to assess patients with TIA in 2017 was greatest in large volume hospitals (93%), followed by medium volume hospitals (82%), and then small volume hospitals (72%). However, this difference was not significant (Figure 11 and Table 21).

Table 21 Changes in access to services for patients with transient ischaemic attack by hospital volume (2007, 2011, 2017)

Stroke volume	Small (<100 admissions)			Medium (100-349 admissions)			Large (350+ admissions)		
	2007 N=38 n (%)	2011 N=31 n (%)	2017 N=25 n (%)	2007 N=62 n (%)	2011 N=55 n (%)	2017 N=60 n (%)	2007 N=25 n (%)	2011 N=23 n (%)	2017 N=27 n (%)
Defined and documented processes for assessing patients with TIA	12 (39)[1]	16 (52)	18 (72)	32 (55)[1]	35 (64)	49 (82)	19 (83)[1]	21 (91)	25 (93)
Presence of TIA/stroke rapid outpatient assessment clinic	8 (26)[2]	9 (29)[3]	11 (44)[4]	21 (36)[2]	25 (45)[3]	25 (42)[4]	21 (91)[2]	17 (74)[3]	21 (78)[4]

TIA: transient ischaemic attack; [1]response obtained from 2009 survey; [2]all hospitals; [3]admit all TIAs or have TIA/stroke rapid outpatient clinic; [4]admit all TIAs or rapid access within 48hrs for hospitals who do not admit all patients with TIA



Small: <100 annual stroke admissions; Medium: 100-349; Large: 350+

Figure 11 Changes in reported use of policies and processes for assessing patients with transient ischaemic attack by hospital volume (2009, 2011, 2017)

4 RESULTS FROM THE CLINICAL AUDITS OF PATIENTS ACROSS THE YEARS

4.1 Clinical Audit: Progress report over ten years (2007-2017)

In 2007, there were 2530 patient medical records audited from 77 hospitals that had 40 or more stroke admissions in the previous year. This increased to 3978 records in 2017 from 108 hospitals. Table 22 summarises hospital participation and number of cases completed for each audit.

Table 22 Total number of hospitals participating in the clinical audit (2007-2017)

	2007		2009		2011		2013		2015		2017	
	Hospitals	Cases	Hospitals	Cases	Hospitals	Cases	Hospitals	Cases	Hospitals	Cases	Hospitals	Cases
Private[1]	4	133	4	130	3	77	5	171	6	214	4	112
Public												
< 40[1, 2]	8	61	8	93	12	125	16	165	4	62	5	102
≥ 40[2]	77	2530	84	3084	93	3346	103	3405	102	3811	108	3978

[1]excluded from the entire analysis; [2]stroke admissions in previous year

4.1.1 Characteristics of patients

The baseline patient demographics, stroke types, variables known to predict stroke severity, and risk factors prior to admission of the clinical audit from 2007-2017 are presented in Table 23. The median age was similar (range 75-77 years). Just over half of the patients in each audit were men. From 2007 to 2017, a small proportion of the audited patients (3% or less) identified as Aboriginal and/or Torres Strait Islander. The proportion of patients with ischaemic stroke increased from 73% in 2007 to 82% in 2017 (OR 1.07, 95% CI 1.05, 1.08) (Figure 12). There was variability in the proportion of patients who were independent prior to admission (mRS: 0-2). Variables used to account for stroke severity indicate that in 2017 patients generally experienced milder strokes than in previous audits. Two-thirds of patients in each audit had multiple risk factors for stroke. The most prevalent risk factor in all audits was hypertension, with two in five patients also presenting with known hypercholesterolemia.

Table 23 Patient characteristics over time (2007-2017)

	2007 N=2530 n (%)	2009 N=3084 n (%)	2011 N=3346 n (%)	2013 N=3405 n (%)	2015 N=3811 n (%)	2017 N=3978 n (%)
Patient Demographics						
Age, years – median (Q1, Q3)	76 (65, 83)	77 (66, 84)	76 (65, 84)	76 (65, 84)	75 (65, 84)	75 (65, 83)
Sex, men	1321 (52)	1627 (53)	1772 (53)	1853 (54)	2113 (55)	2187 (55)
Patient identifying as Aboriginal and/or Torres Strait Islander	33 (1)	64 (2)	97 (3)	108 (3)	106 (3)	96 (2)
Stroke type						
Ischaemic	1800 (73)	2278 (76)	2504 (78)	2678 (80)	3004 (79)	3267 (82)
Intracerebral haemorrhage	327 (13)	484 (16)	508 (16)	406 (12)	512 (13)	491 (12)
Undetermined	346 (14)	250 (8)	217 (6)	265 (8)	295 (8)	220 (6)
Pre-stroke information						
Independence prior to admission (mRS 0-2)	2016 (82)	1913 (68)	2235 (74)	2274 (73)	3053 (80)	3207 (81)
Stroke severity						
Arm deficit on admission	1830 (75)	2133 (72)	2249 (70)	2229 (67)[1]	2241 (62)	2295 (60)
Speech/communication impairment on admission	1589 (66)	1928 (67)	2015 (64)	1915 (59)[1]	2127 (59)	2183 (57)
Incontinence within 72 hours[2]	940 (39)	1255 (43)	1265 (40)	1221 (38)[1]	1266 (34)	1311 (35)
Inability to walk on admission	1596 (67)	2079 (69)	2125 (65)	2297 (70)[1]	2082 (56)	2067 (54)
Risk factors prior to admission						
Atrial fibrillation	627 (27)	775 (31)	934 (36)	908 (33)	957 (29)	969 (27)
Previous stroke	587 (26)	701 (27)	761 (28)	689 (25)	861 (26)	849 (23)
Previous TIA	394 (18)	442 (19)	547 (22)	484 (18)	499 (16)	467 (13)
Diabetes mellitus	550 (24)	716 (28)	811 (30)	860 (30)	956 (28)	970 (26)
Hypercholesterolemia	861 (41)	1133 (45)	1336 (51)	1358 (48)	1425 (44)	1537 (42)
Hypertension	1705 (71)	2035 (72)	2249 (74)	2289 (73)	2482 (70)	2634 (69)
Ischaemic heart disease	720 (32)[3]	765 (30)	887 (34)	851 (31)	939 (29)	916 (25)
High alcohol consumption	210 (11)	280 (13)	328 (14)	332 (13)	381 (13)	333 (10)
Current smoker	380 (18)	484 (20)	485 (19)	514 (19)	522 (17)	555 (16)
Past Smoker	-	896 (42)	631 (39)	631 (37)	994 (37)	1000 (33)

Q1: 1st quartile; Q3: 3rd quartile; mRS: modified Rankin Scale; TIA: transient ischaemic attack; [1]patients receiving palliative care were included as yes; [2]from stroke onset, except 2013 which was from Emergency Department presentation; [3]myocardial infarction

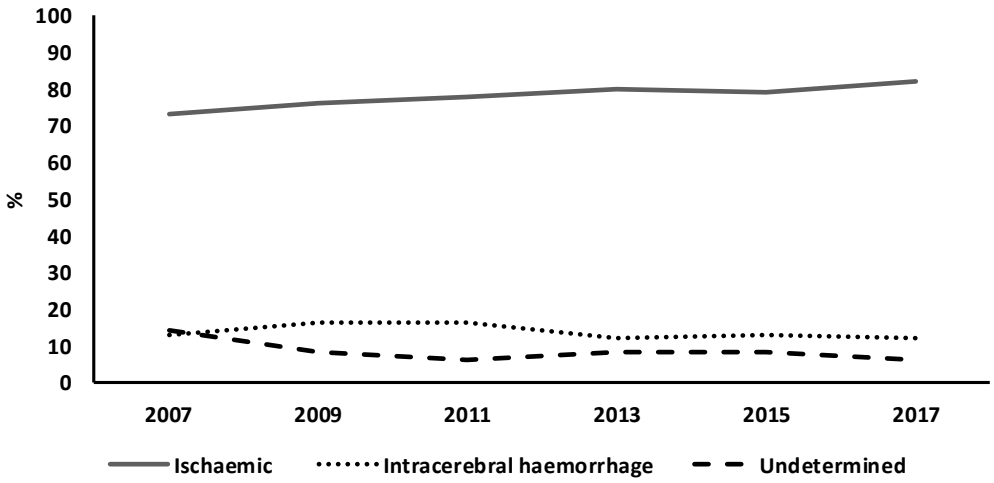


Figure 12 Distribution of stroke types (2007-2017)

4.1.2 Time-critical assessment or therapy

The median time from onset of stroke to ED presentation varied over the audits. The shortest median time was in 2011 at 2.1 hours, with 4.2 hours in 2013 being the longest (Table 24). Access to timely brain scan remained greater than 88% across all audits. From 2007 to 2017, the number of patients who received thrombolysis increased significantly from 3% to 11% (OR 1.16, 95% CI 1.13, 1.18) (Figure 13). More patients received aspirin within 48 hours in 2017 compared to earlier audits.

Table 24 Changes in presentation, brain imaging and time-critical reperfusion therapy over time (2007-2017)

	2007 N=2530 n (%)	2009 N=3084 n (%)	2011 N=3346 n (%)	2013 N=3405 n (%)	2015 N=3811 n (%)	2017 N=3978 n (%)	**2007-2017 Year effect OR (95% CI)**
Time from onset to ED - median (Q1, Q3) hours[1]	3.8 (1, 14)	2.2 (1, 6)	2.1 (1, 6)	4.2 (2, 17)	3.5 (1, 10)	3.5 (1, 10)	0.08 (0.05-0.11)
Brain scan within 24 hours of ED	2206 (88)	2796 (92)	2983 (92)	3051 (94)	3435 (91)	3590 (91)	1.01 (0.99-1.03)
Received intravenous thrombolysis (ischaemic stroke)[2]	53 (3)	80 (4)	183 (7)	178 (7)	224 (7)	364 (11)	1.16 (1.13-1.18)
Aspirin within 48 hours of ED (ischaemic stroke)[2]	930 (56)	1255 (64)	1249 (65)	1399 (68)	1808 (71)	1915 (72)	1.08 (1.06-1.09)

OR: odds ratio; CI: confidence interval; ED: Emergency Department; Q1: 1st quartile; Q3: 3rd quartile; [1]known dates/times; [2]response options changed over time

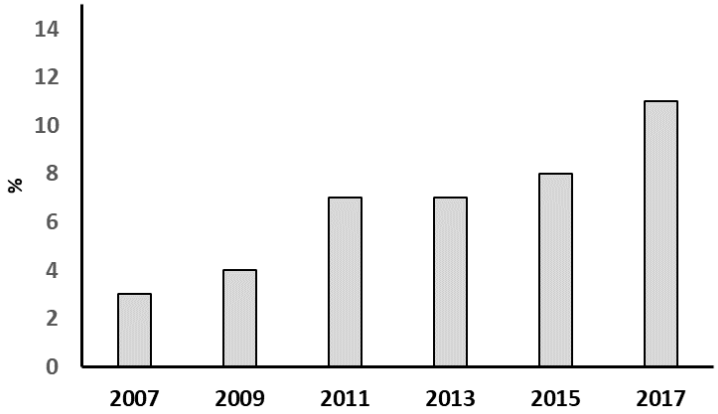


Figure 13 Proportion of patients who received intravenous thrombolysis if admitted with ischaemic stroke (2007-2017)

4.1.3 Stroke unit care

The proportion of patients who had been treated in a stroke unit increased from 53% in 2007 to 70% in 2017 (OR 1.18, 95% CI 1.17, 1.20) (Table 25 and Figure 14). Although the question and response options changed over time, more patients appeared to have a swallow screen or assessment prior to oral intake (increase from 51% in 2007 to 64% in 2017; OR 1.06, 95% CI 1.05, 1.07).

Table 25 Changes in access to stroke unit care over time (2007-2017)

	2007 N=2530 n (%)	2009 N=3084 n (%)	2011 N=3346 n (%)	2013 N=3405 n (%)	2015 N=3811 n (%)	2017 N=3978 n (%)	**2007-2017 Year effect OR (95% CI)**
Received SU care	1350 (53)	1542 (50)	2012 (60)	2028 (60)	2550 (67)	2795 (70)	1.18 (1.17-1.20)
Swallow screen/assessment prior to food, fluid or oral medications[1]	1279 (51)	1622 (53)	1912 (57)	1834 (54)	2186 (57)	2555 (64)	1.06 (1.05-1.07)

OR: odds ratio; CI: confidence interval; SU: stroke unit; [1]question asked differently over the years

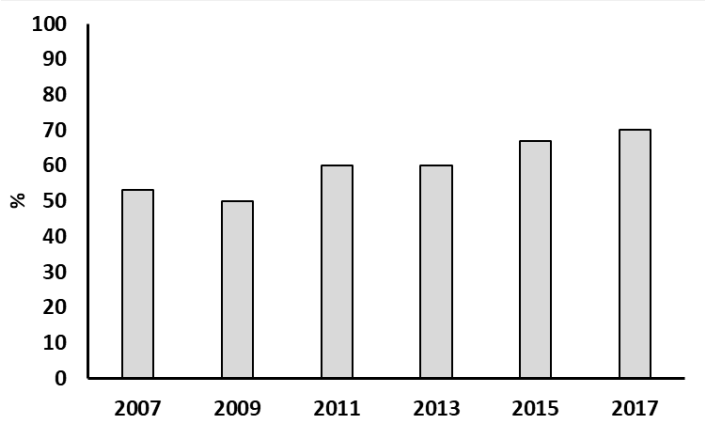


Figure 14 Access to stroke unit care (2007-2017)

4.1.4 Early interdisciplinary assessment and intervention

From 2007 to 2017, the proportion of patients who accessed timely allied health, including physiotherapy, occupational therapy, speech pathology and social work increased over time (Table 26). Direct comparisons of those who had their mood assessed was difficult. However, from 2011 to 2017 when the question remained consistent, an increase in mood assessment was evident (2011 15%, 2017 22%; OR 1.11, 95% CI 1.09, 1.13). Of concern, four in five patients were still missing out on this process in 2017. Improvements in access to team meetings were evident over the audits, with variation seen in the use of management plans for incontinent patients.

Table 26 Changes in interdisciplinary assessment and intervention (2007-2017)

	2007 N=2530 n (%)	2009 N=3084 n (%)	2011 N=3346 n (%)	2013 N=3405 n (%)	2015 N=3811 n (%)	2017 N=3978 n (%)	**2007-2017 Year effect OR (95% CI)**
Physiotherapy assessment within 48 hours of ED[1]	1502 (60)[2]	1764 (60)	2031 (64)	2200 (71)[3]	2595 (68)	2705 (68)	1.05 (1.04-1.06)
Occupational therapy assessment within 48 hours of ED[1]	1013 (40)[2]	1129 (39)	1307 (42)	1552 (51)[3]	2021 (56)	2032 (55)	1.09 (1.08-1.10)
Speech pathologist assessment within 48 hours of ED	-	1814 (63)	2002 (64)	2048 (68)[3]	2398 (69)	2517 (70)	1.05 (1.04-1.06)[4]
Social worker within 7 days of ED[1, 5]	857 (34)	1164 (41)	1230 (40)	1358 (46)[3]	1596 (51)	1708 (56)	1.10 (1.09-1.11)
Mood assessed during admission[5]	752 (30)	-	510 (15)	539 (17)[3]	798 (21)	888 (22)	1.11 (1.09, 1.13)[6]
Incontinent patients with continence plan	425 (45)	409 (33)	316 (25)	236 (25)[3]	412 (33)	428 (33)	0.97 (0.96-0.99)
Team met with patient/family to discuss management plan[5]	1357 (54)	1019 (33)	1128 (34)	1169 (34)	3046 (80)	3352 (84)	1.26 (1.25-1.27)

OR: odds ratio; CI: confidence interval; ED: Emergency Department; [1]with exception of 2007- excludes patients not requiring therapy; [2]within 2 days; [3]excludes those receiving palliative care in 2013; [4]from 2009 to 2017; [5]response options/questions changed over years; [6]from 2011-2017

4.1.5 Minimising the risk of another stroke

More patients received advice on risk factor modification with the percentage increasing from 42% in 2007 to 62% in 2017 (Table 27 and Figure 15). Improvements were also seen in prescription practices of lipid lowering medication at discharge for those with ischaemic stroke (OR 1.09, 95% CI 1.07, 1.11). Prescription of antihypertensive medications at time of discharge was 82% in 2011, with the lowest at 73% in 2015. The proportion of patients with ischaemic stroke on antithrombotic medications at discharge was 95% or more in all audits, with little change over time.

Table 27 Changes in secondary prevention practices over time (2007-2017)

	2007 N=2530 n (%)	2009 N=3084 n (%)	2011 N=3346 n (%)	2013[1] N=3405 n (%)	2015 N=3811 n (%)	2017 N=3978 n (%)	**2007-2017 Year effect OR (95% CI)**
Risk factor advice for those discharged to community	573 (42)[2]	631 (46)	760 (50)	843 (53)	1174 (56)	1266 (62)	1.10 (1.09-1.12)
Discharged to community on antihypertensives[3]	1017 (76)	1094 (79)	1243 (82)	1277 (79)	1508 (73)	1483 (75)	0.97 (0.96-0.99)
Discharged to community on antithrombotics (ischaemic stroke)[3]	944 (95)	1099 (95)	1202 (97)	1344 (97)	1640 (95)	1634 (96)	1.00 (0.97-1.04)
Discharged to community on lipids (ischaemic stroke)[3]	655 (65)	901 (79)	1016 (83)	1129 (85)	1387 (81)	1434 (85)	1.09 (1.07-1.11)

OR: odds ratio; CI: confidence interval; [1]excludes those receiving palliative care; [2]derived differently in 2007; [3]excludes those contraindicated or refused treatment

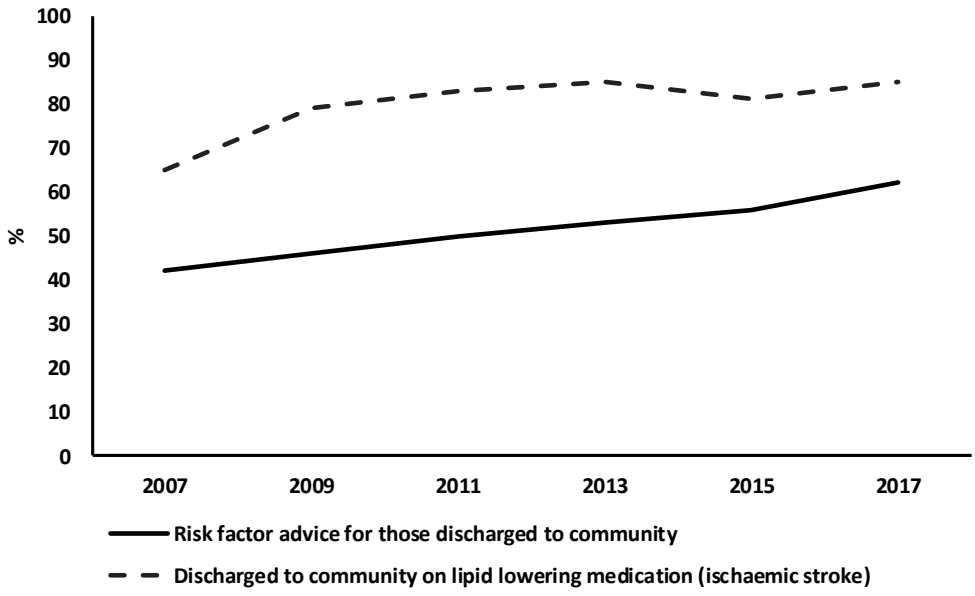


Figure 15 Changes in secondary prevention practices (2007-2017)

4.1.6 The transition from hospital care

More patients/families were involved with developing a discharge care plan with the team over time, increasing from 58% in 2007 to 65% in 2017 (Table 28). From 2007 to 2017, an increasing trend was observed for general practitioners being provided with a discharge summary (2007: 79%, 2017: 96%; OR 1.23, 95% CI 1.21, 1.25). Practices around supporting carers in the community improved over the audits, with more receiving carer training (2007: 24%, 2017: 49%; OR 1.13, 95% CI 1.10, 1.15) or an assessment of their needs for support (2009: 53%, 2017: 57%; OR 1.07, 95% CI 1.03, 1.11) in the 2017 audit.

Table 28 Changes in processes to assist in the transition from hospital (2007-2017)[1]

	2007 N=2530 n (%)	2009 N=3084 n (%)	2011 N=3346 n (%)	2013 N=3405 n (%)	2015 N=3811 n (%)	2017 N=3978 n (%)	**2007-2017 Year effect OR (95% CI)**
Care plan developed with team and patient/family[2]	793 (58)	807 (59)	839 (55)	897 (55)	1166 (57)	1296 (65)	1.03 (1.02-1.05)
GP provided with discharge summary[3]	1666 (79)	2186 (86)	2363 (86)	2432 (87)	2804 (95)	2842 (96)	1.23 (1.21-1.25)
Carer received training[2]	300 (24)	206 (54)	154 (45)	144 (44)	208 (45)	186 (49)	1.13 (1.10-1.15)
Carer need for support assessed[3]	-	224 (53)	172 (47)	157 (45)	255 (55)	214 (57)	1.07 (1.03-1.11)[4]

OR: odds ratio; CI: confidence interval; GP: general practitioner; [1]excludes those receiving palliative care in 2013 and different response options over the years; [2]if discharged from hospital; [3]excludes deaths and those where not applicable, i.e. discharged to inpatient rehabilitation; [4]from 2009 to 2017

4.1.7 Patient outcomes: Hospital matched analysis by year

Fifty-one hospitals completed all six clinical audits from 2007-2017. These hospitals were included in a matched analysis over time to compare in-hospital patient outcomes. Of the patients audited in 2017, data for 51% was available for length of hospital stay analysis. Median length of hospital stay for all patients decreased from 6.3 days in 2007 to 5.0 days in 2017 (Table 29). A similar trend in length of stay was observed for those discharged.

Table 29 Changes in length of stay in matched hospitals that participated in each audit (2007-2017)

	2007 N=1765[1]	2009 N=1955[1]	2011 N=2086[1]	2013 N=1883[1]	2015 N=2114[1]	2017 N=2045[1]
Length of stay days (all) - median (Q1,Q3)	6.3 (3, 13)	6.6 (3, 14)	6.0 (3, 12)	5.2 (3, 9)	5.0 (3, 10)	5.0 (3, 8)
Length of stay days (discharged) - median (Q1, Q3)	6.4 (3, 13)	7.0 (4, 14)	6.0 (3, 12)	5.3 (3, 9)	5.0 (3, 9)	5.0 (3, 8)

Q1: 1st quartile; Q3: 3rd quartile; CI: confidence interval; [1]known length of stay

Table 30 summarises the in-hospital patient outcomes for matched hospitals that participated in each audit (output is not adjusted for patient characteristics). Overall, in 2017 compared to 2007, there were fewer in-hospital deaths, with similar proportions of patients dead or dependent on discharge (mRS 3-6). Changes to the discharge destinations were seen with fewer patients discharged to an aged care facility (2007: 5%; 2017:2%), and more received inpatient rehabilitation in later audits (2007: 28%; 2017: 33%).

Table 30 Changes in in-hospital patient outcomes for matched hospitals that participated in each audit (2007-2017)

	2007 N=1835 n (%)	2009 N=2014 n (%)	2011 N=2142 n (%)	2013 N=1947 n (%)	2015 N=2122 n (%)	2017 N=2063 n (%)
Died	226 (12)	294 (15)	290 (14)	210 (11)	238 (11)	192 (9)
Death or dependency (mRS 3-6)	1045 (57)	1358 (71)	1386 (68)	1183 (64)	1203 (57)	1141 (55)
Discharged to usual residence[1]	848 (53)	834 (48)	895 (48)	804 (46)	988 (52)	932 (50)
Discharged to aged care facility[2]	87 (5)	96 (6)	84 (5)	46 (3)	52 (3)	38 (2)
Discharged to inpatient rehabilitation	447 (28)	522 (30)	610 (33)	619 (36)	605 (32)	614 (33)
Discharged to usual residence[1] or inpatient rehabilitation	1295 (80)	1356 (79)	1505 (81)	1423 (82)	1593 (85)	1546 (83)

mRS: modified Rankin Scale; [1]includes discharged to home/relative or return to residential care +/-support; [2]new transfer to aged care

After adjusting the outcomes for patient characteristics known to influence outcomes (age, gender, prior history of stroke, stroke type, stroke severity, premorbid function, geographic location, year of audit, and correlation within the hospital), there was still a significant reduction in length of stay evident over the audits, with a greater number of patients being discharged directly to inpatient rehabilitation and fewer to an aged care facility (Table 31). No differences in death or dependency over the audits were seen.

Table 31 Changes in patient outcomes (2007-2017), adjusted for patient characteristics

	2007-2017 Year effect		
	Coefficient	(95% CI)	p-value
Length of stay days (all) - median (Q1, Q3)	-0.17	-0.22, -0.14	<0.001
	2007-2017 Year effect		
	OR	(95% CI)	p-value
Died	0.98	0.96, 1.01	0.09
Death or dependency (mRS 3-6)	1.01	0.99, 1.03	0.07
Discharged to usual residence[1]	0.96	0.95, 0.97	<0.001
Discharged to aged care facility[2]	0.90	0.86, 0.93	<0.001
Discharged to inpatient rehabilitation	1.05	1.03, 1.07	<0.001
Discharged to usual residence[1] or inpatient rehabilitation	1.01	0.99, 1.03	0.4

All analyses adjusted for age, gender, prior history of stroke, stroke type, stroke severity (inability to walk, arm weakness and speech impairment on admission, and incontinence within 72 hours), premorbid function, geographic location, year of audit and correlation within hospital; Q1: 1st quartile; Q3: 3rd quartile; CI: confidence interval; OR: odds ratio; mRS: modified Rankin Scale; [1]includes discharge to home/relative or return to residential care +/-support; [2]new transfer to aged care

4.2 Clinical Audit: Urban versus rural comparisons over early, mid and late time periods

For consistency, urban versus rural comparisons were performed using the 86 hospitals that participated in each of the following time periods: early (2007-2009), mid (2011-2013) and late (2015-2017).

4.2.1 Time-critical assessment or therapy

Access to a timely brain scan did not change over the periods based on urban/rural location, with more than 90% of patients receiving a brain scan within 24 hours in all periods (Table 32). The proportion of patients receiving thrombolysis increased over the periods regardless of urban/rural status. Although numbers were small, the overall percentage of those thrombolysed in rural locations (13%) was slightly greater than in urban hospitals (10%) in 2017 (not significant). Few patients in rural hospitals outside Victoria were thrombolysed in any period (Victoria – early: 6%, mid: 10%, late: 18%, compared to other areas – early: 1%, mid: 2%, late: 0%). No change was apparent in the provision of aspirin within 48 hours in rural hospitals, but an increase was evident in urban locations in the late (73%) compared to the early (61%) period.

Table 32 Urban versus rural comparisons for time-critical assessment and therapy (early, mid, late periods)

	Urban			Rural		
	Early N=4985 n (%)	Mid N=5667 n (%)	Late N=6108 n (%)	Early N=302 n (%)	Mid N=301 n (%)	Late N=353 n (%)
Brain scan within 24 hours of ED	4483 (91)	5117 (93)	5528 (91)	271 (91)	274 (94)	319 (93)
Received intravenous thrombolysis (ischaemic stroke)	122 (3)	334 (8)	501 (10)	8 (4)	17 (8)	34 (13)
Aspirin within 48 hours of ED (ischaemic stroke)[1]	1956 (61)	2302 (67)	3023 (73)	102 (58)	100 (61)	133 (58)

ED: Emergency Department; [1]response options changed over time

4.2.2 Stroke unit care

Access to stroke unit care improved in urban hospitals over the periods (Figure 16), however no change was evident in rural hospitals (Table 33). A similar proportion of patients in both urban and rural hospitals had a swallow screen or assessment prior to food, fluids or oral medications in the late period, with this process performed less commonly in urban hospitals compared to rural hospitals in the early period.

Table 33 Urban versus rural comparisons for stroke unit care (early, mid, late periods)

	Urban			Rural		
	Early N=4985 n (%)	Mid N=5667 n (%)	Late N=6108 n (%)	Early N=302 n (%)	Mid N=301 n (%)	Late N=353 n (%)
Received SU care	2727 (55)	3796 (67)	4630 (76)	53 (18)	61 (20)	70 (20)
Swallow screen/assessment prior to food, fluid or oral medications[1]	2546 (51)	3216 (57)	3771 (62)	187 (62)	172 (57)	216 (61)

SU: stroke unit; [1]question asked differently over the years

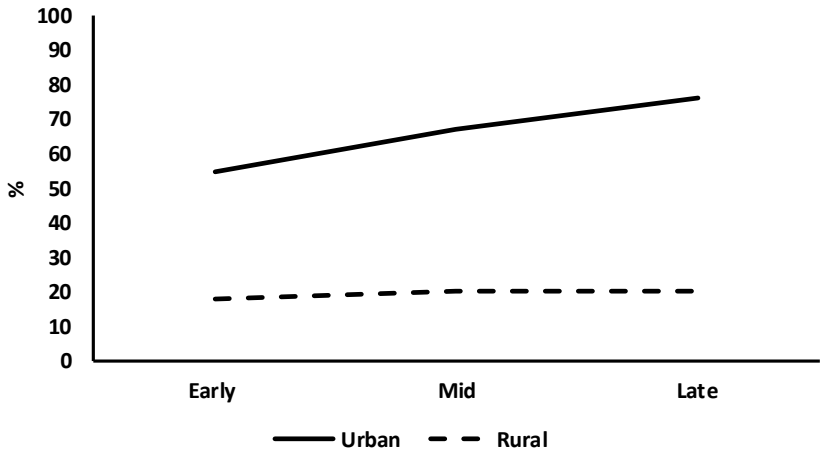


Figure 16 Urban versus rural comparisons for access to stroke unit care (early, mid, late periods)

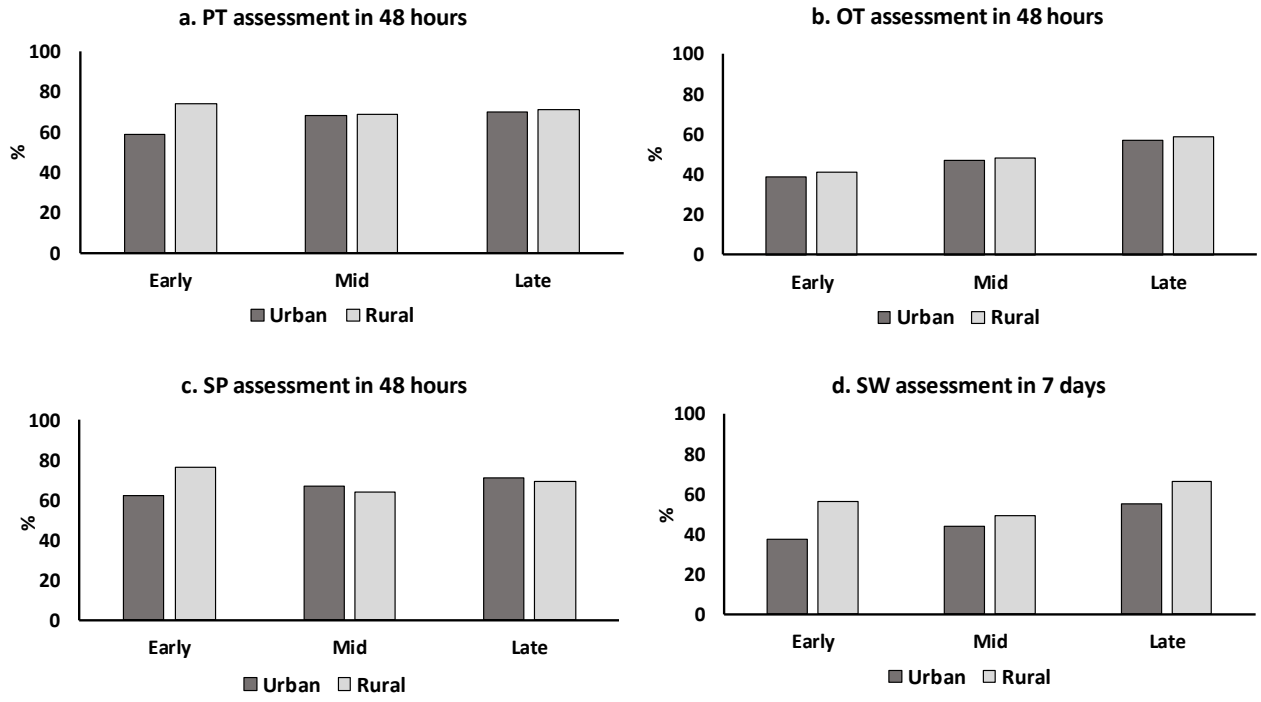
4.2.3 Early interdisciplinary assessment and intervention

An improvement in access to timely physiotherapy was seen over the periods in urban hospitals, with no significant different in rural settings. (Figure 17a). A greater proportion of patients accessed occupational therapy within 48 hours, and social work within seven days over the periods, regardless of rural status (Table 34). Direct comparisons for mood assessments and team meetings were difficult due to question and response changes. However, from the mid to late period, increases in mood assessment were evident in urban hospitals (mid: 16%, late: 22%, p<0.001), but not so in rural hospitals (mid: 11%, late: 12%). Fewer incontinent patients received continence plans in the late period compared to earlier in urban hospitals (OR 0.89, 95% CI 0.83, 0.96). While there was no change in rural hospitals, large gaps in practice remain in relation to this process in both rural and urban hospitals.

Table 34 Urban versus rural comparisons for early interdisciplinary assessment and interventions (early, mid, late periods)

	Urban			Rural		
	Early N=4985 n (%)	Mid N=5667 n (%)	Late N=6108 n (%)	Early N=302 n (%)	Mid N=301 n (%)	Late N=353 n (%)
Physiotherapy assessment within 48 hours of ED[1]	2875 (59)[2]	3600 (68)[3]	4251 (70)	210 (74)[2]	195 (69)[3]	250 (71)
Occupational therapy assessment within 48 hours of ED[1]	1903 (39)[2]	2433 (47)[3]	3229 (57)	116 (41)[2]	135 (48)[3]	201 (59)
Speech pathologist assessment within 48 hours of ED	1602 (62)[4]	3444 (67)[3]	3939 (71)	127 (76)[4]	178 (64)[3]	229 (69)
Social worker within 7 days of ED[1, 5]	1776 (37)	2237 (44)[3]	2623 (55)	152 (56)	138 (49)[3]	214 (66)
Mood assessed[5]	631 (28)[6]	895 (16)[3]	1360 (22)	42 (35)[6]	30 (11)[3]	41 (12)
Incontinent patients with continence plan	733 (38)	497 (27)[3]	640 (32)	20 (16)	11 (12)[3]	21 (19)
Team met with patient/family to discuss management[5]	2103 (42)	1957 (35)	4975 (81)	149 (49)	112 (37)	263 (75)

ED: Emergency Department; [1]excludes patients not requiring therapy (except in 2007); [2]within 2 days in 2007; [3]excludes those receiving palliative care in 2013; [4]not recorded in 2007; [5]response options/questions changed over years; [6]not recorded in 2009



PT: physiotherapy; OT: occupational therapy; SP: speech pathology; SW: social work

Figure 17 Urban versus rural comparisons for early interdisciplinary assessment (early, mid, late periods)

4.2.4 Minimising risk of another stroke

In both rural and urban hospitals, a significant increase in patients receiving risk factor modification advice was seen over the periods, with improvements in urban hospitals over time in prescription of lipid lowering medication (if ischaemic stroke) (Table 35). Nevertheless, gaps in care still exist, with one in two patients in rural hospitals, and one in three in urban hospitals still missing out on risk factor advice. A significant decrease over the periods was seen in urban hospitals in prescription of antihypertensives. Prescription of antithrombotics remained high, with over 95% of patients, regardless of urban/rural status, being discharged on this medication in the late period.

Table 35 Urban versus rural comparisons for secondary prevention practices (early, mid, late periods)[1]

	Urban			Rural		
	Early N=4985 n (%)	Mid N=5667 n (%)	Late N=6108 n (%)	Early N=302 n (%)	Mid N=301 n (%)	Late N=353 n (%)
Risk factor advise for those discharged to community[2]	1080 (45)	1359 (52)	1900 (59)	53 (36)	61 (43)	91 (52)
Discharged to community on antihypertensives[3]	1865 (77)	2088 (80)	2301 (73)	126 (83)	114 (84)	132 (77)
Discharged to community on antithrombotics (ischaemic stroke)[3]	1818 (95)	2180 (97)	2633 (95)	98 (94)	103 (95)	132 (96)
Discharged to community on lipids (ischaemic stroke)[3]	1390 (73)	1831 (82)	2261 (83)	68 (65)	88 (81)	106 (77)

[1]response options varied over the years; [2]derived differently in 2007; [3]excludes those where contraindicated or who refused treatment

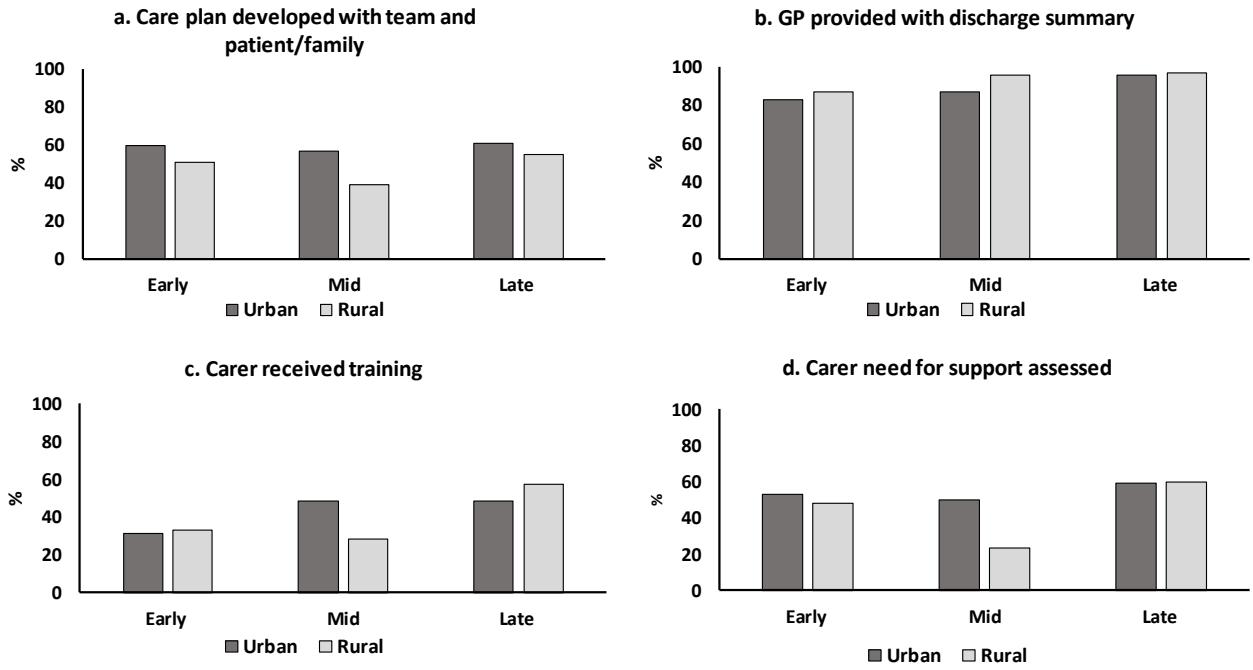
4.2.5 The transition from hospital care

Over the periods, the proportion of general practitioners provided with a discharge summary increased, with this practice being undertaken almost universally in the late period regardless of urban/rural location (Figure 18). Limited change was seen in the use of care plans over the periods (Table 36). The proportion of carers who received training improved in both urban and rural hospitals over time and there was an improvement in carer needs assessment over the periods in urban hospitals (OR 1.27, 95% CI 1.10, 1.47).

Table 36 Urban versus rural comparisons process to assist with transition from the hospital (early, mid, late periods)[1]

	Urban			Rural		
	Early N=4985 n (%)	Mid N=5667 n (%)	Late N=6108 n (%)	Early N=302 n (%)	Mid N=301 n (%)	Late N=353 n (%)
Care plan developed with team and patient/family[2]	1459 (60)	1491 (56)	1906 (61)	76 (51)	56 (39)	95 (55)
GP provided with discharge summary[3]	3405 (83)	4037 (87)	4419 (96)	226 (87)	234 (96)	289 (97)
Carer received training[2]	443 (31)	248 (48)	308 (48)	32 (34)	8 (28)	20 (57)
Carer need for support assessed[2, 4]	196 (53)	281 (50)	381 (59)	12 (48)	7 (23)	21 (60)

GP: general practitioner; [1]different response options over years and excludes palliative care in 2013; [2]if discharged from hospital; [3]excludes deaths and where not applicable, i.e discharged to inpatient rehabilitation; [4]question not asked in 2007



GP: general practitioner

Figure 18 Urban versus rural comparisons for processes to assist with transition from the hospital (early, mid, late periods)

4.3 Clinical Audit: Comparisons by annual stroke admission volume over early, mid and late time periods

Hospitals were classified into small (<100), medium (100-349) and large (350+) volume hospitals according to annual stroke admission volume and compared over three periods: early (2007-2009), mid (2011-2013) and late (2015-2017).

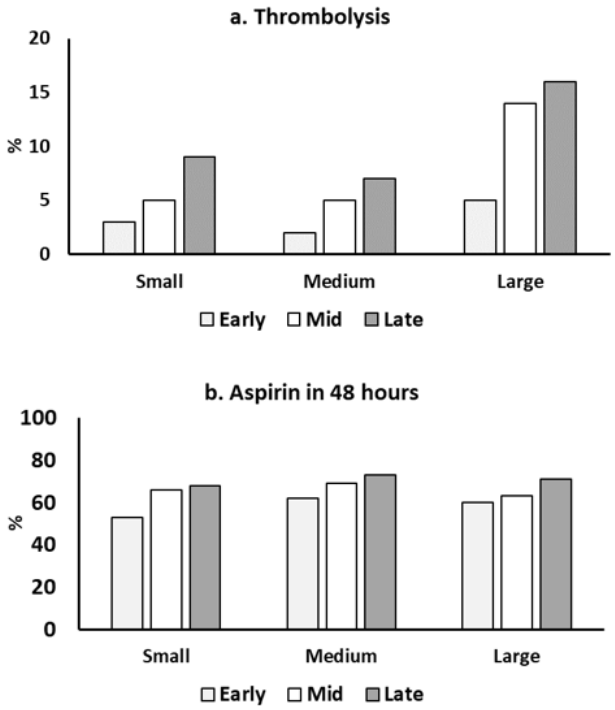
4.3.1 Time-critical assessment or therapy

Nearly all patients (90%) received brain imaging within 24 hours of stroke onset, irrespective of stroke admission volume and period (Table 37). A greater proportion of eligible patients received intravenous thrombolysis in large volume hospitals compared to medium and small volume hospitals in all periods ($p<0.001$). However, over the periods, improvements in thrombolysis provision were seen universally regardless of volume (Figure 19a). Similarly, a greater proportion of patients with ischaemic stroke received aspirin within 48 hours in the late period compared to earlier, in all hospital volumes (Figure 19b).

Table 37 Hospital volume comparisons for time-critical assessment or therapy (early, mid, late periods)

Stroke volume	Small (<100 admissions)			Medium (100-349 admissions)			Large (350+ admissions)		
	Early N=554 n (%)	Mid N=673 n (%)	Late N=501 n (%)	Early N=3194 n (%)	Mid N=3315 n (%)	Late N=3733 n (%)	Early N=1539 n (%)	Mid N=1980 n (%)	Late N=2227 n (%)
Brain scan within 24 hours of ED	476 (89)	605 (93)	441 (90)	2891 (92)	2998 (94)	3401 (92)	1387 (91)	1788 (93)	2005 (91)
Received intravenous thrombolysis (ischaemic stroke)	12 (3)	21 (5)	35 (9)	58 (2)	120 (5)	214 (7)	60 (5)	210 (14)	286 (16)
Aspirin within 48 hours (ischaemic stroke)[1]	167 (53)	239 (66)	213 (68)	1286 (62)	1433 (69)	1896 (73)	605 (60)	730 (63)	1047 (71)

ED: Emergency Department; [1]response options changed over time



Small: <100 annual stroke admissions; Medium: 100-349; Large: 350+

Figure 19 Hospital volume comparisons for thrombolysis and timely aspirin (early, mid, late periods)

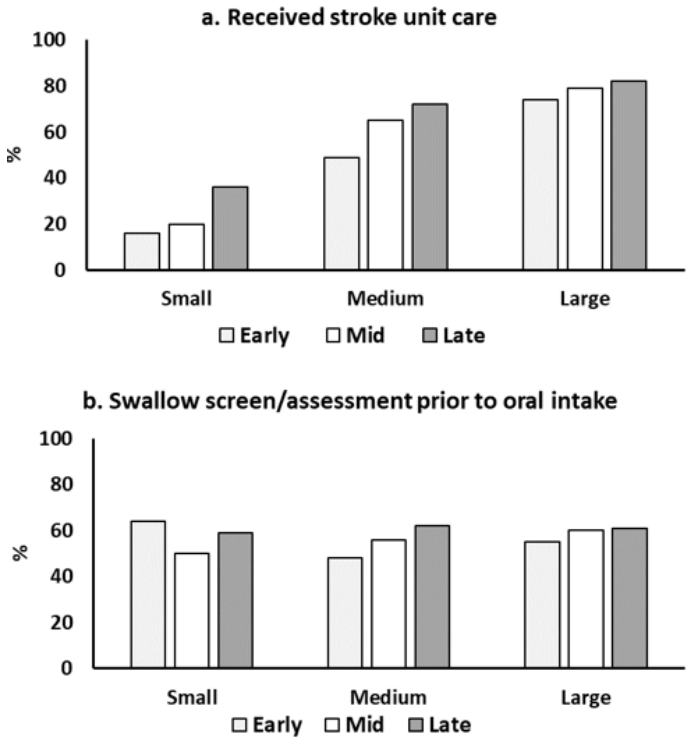
4.3.2 Stroke unit care

Although significant improvements in access to stroke unit care were seen over the periods in all hospital volumes (Table 38), a larger proportion of patients accessed the stroke unit in large and medium volume hospitals compared to smaller volume hospitals (Figure 20a). Variability in swallow screen/assessment prior to oral intake was evident over the periods, with similar adherence seen in the late period regardless of hospital volume (small: 59%, medium: 62%, large: 61%).

Table 38 Hospital volume comparisons for stroke unit care (early, mid, late periods)

Stroke volume	Small (<100 admissions)			Medium (100-349 admissions)			Large (350+ admissions)		
	Early N=554 n (%)	Mid N=673 n (%)	Late N=501 n (%)	Early N=3194 n (%)	Mid N=3315 n (%)	Late N=3733 n (%)	Early N=1539 n (%)	Mid N=1980 n (%)	Late N=2227 n (%)
Received SU care	86 (16)	134 (20)	180 (36)	1549 (49)	2157 (65)	2701 (72)	1145 (74)	1566 (79)	1819 (82)
Swallow screen / assessment prior to food, fluid or oral medications[1]	355 (64)	336 (50)	297 (59)	1525 (48)	1857 (56)	2321 (62)	853 (55)	1195 (60)	1369 (61)

SU: stroke unit; [1]question asked differently over the years



Small: <100 annual stroke admissions; Medium: 100-349; Large: 350+

Figure 20 Hospital volume comparisons for stroke unit care (early, mid, late periods)

4.3.3 Early interdisciplinary assessment and intervention

More patients in all hospitals irrespective of stroke volume accessed physiotherapy and occupational therapy within 48 hours in the late period compared to earlier (Table 39). Variability existed in access to timely speech pathology. Among the audited patients with incontinence, only a third had a continence plan in the late period, this was similar across all hospital volumes.

Table 39 Hospital volume comparisons for early interdisciplinary assessment and intervention (early, mid, late periods)

Stroke volume	Small (<100 admissions)			Medium (100-349 admissions)			Large (350+ admissions)		
	Early N=554 n (%)	Mid N=673 n (%)	Late N=501 n (%)	Early N=3194 n (%)	Mid N=3315 n (%)	Late N=3733 n (%)	Early N=1539 n (%)	Mid N=1980 n (%)	Late N=2227 n (%)
Physiotherapy assessment within 48 hours[1]	336 (64)[2]	401 (65)[3]	359 (72)	1826 (59)[2]	2125 (69)[3]	2656 (71)	923 (61)[2]	1269 (68)[3]	1486 (67)
Occupational therapy assessment within 48 hours[1]	189 (36)[2]	251 (41)[3]	238 (51)	1199 (39)[2]	1475 (48)[3]	2128 (60)	631 (42)[2]	842 (46)[3]	1064 (52)
Speech pathologist assessment within 48 hours[4]	178 (67)	372 (61)[3]	301 (65)	1092 (63)	2121 (70)[3]	2563 (74)	459 (63)	1129 (63)[3]	1304 (67)
Social worker within 7 days[1]	182 (36)	232 (39)[3]	185 (43)	1227 (40)	1401 (47)[3]	1847 (59)	519 (35)	742 (42)[3]	805 (51)
Mood assessed[5, 6]	66 (25)	47 (7)[3]	81 (16)	356 (26)	574 (18)[3]	879 (24)	251 (34)	304 (16)[3]	441 (20)
Incontinent patients with continence plan	46 (19)	31 (13)[3]	49 (33)	458 (38)	267 (26)[3]	350 (30)	249 (42)	210 (30)[3]	262 (33)
Team met with patient/family to discuss management[5]	263 (47)	232 (34)	336 (67)	1365 (43)	1114 (34)	2931 (79)	624 (41)	723 (37)	1971 (89)

ED: Emergency Department; [1]excludes patients not requiring therapy (except in 2007); [2]within 2 days in 2007; [3]excludes those receiving palliative care in 2013; [4]not recorded in 2007; [5]response options/questions changed over years; [6]not recorded in 2009

4.3.4 Minimising the risk of another stroke

Over the periods there was an improvement in provision of risk factor advice in the medium and large volume hospitals (Table 40). Prescription of antithrombotics remained over 90% in all periods for all hospital volumes, with increases seen in the prescription of lipids for those with ischaemic stroke over the periods regardless of hospital volume.

Table 40 Hospital volume comparisons for secondary prevention processes (early, mid, late periods)[1]

Stroke volume	Small (<100 admissions)			Medium (100-349 admissions)			Large (350+ admissions)		
	Early N=554 n (%)	Mid N=673 n (%)	Late N=501 n (%)	Early N=3194 n (%)	Mid N=3315 n (%)	Late N=3733 n (%)	Early N=1539 n (%)	Mid N=1980 n (%)	Late N=2227 n (%)
Risk factor advice for those discharged to community[2]	104 (41)	131 (43)	136 (51)	706 (46)	885 (57)	1224 (61)	323 (41)	404 (46)	631 (57)
Discharged to community on anti-hypertensives[3]	197 (77)	250 (81)	205 (78)	1180 (78)	1233 (81)	1461 (74)	614 (78)	719 (80)	767 (71)
Discharged to community on antithrombotics (ischaemic stroke)[3]	161 (90)	232 (95)	193 (93)	1124 (95)	1300 (97)	1655 (96)	631 (97)	751 (97)	917 (95)
Discharged to community on lipids (ischaemic stroke)[3]	115 (64)	188 (77)	164 (80)	864 (72)	1099 (83)	1434 (84)	479 (74)	632 (83)	769 (80)

[1]response options varied over the years; [2]derived differently in 2007; [3]excludes those where contraindicated or who refused treatment

4.3.5 The transition from hospital care to the community

There was variability across the periods, however, regardless of hospital volume, approximately two in three patients had a discharge care plan that was developed in conjunction with the stroke team and patient/family in the late period (Table 41). A significant increase in the proportion of general practitioners who were provided with a discharge summary and in the use of carer training was observed over all periods in all hospitals.

Table 41 Hospital volume comparisons for processes to assist with the transition from hospital to the community (early, mid, late periods)[1]

Stroke volume	Small (<100 admissions)			Medium (100-349 admissions)			Large (350+ admissions)		
	Early N=554 n (%)	Mid N=673 n (%)	Late N=501 n (%)	Early N=3194 n (%)	Mid N=3315 n (%)	Late N=3733 n (%)	Early N=1539 n (%)	Mid N=1980 n (%)	Late N=2227 n (%)
Care plan developed with team and patient/family[2]	162 (64)	154 (51)	156 (60)	886 (59)	875 (56)	1175 (60)	487 (61)	518 (57)	670 (62)
GP provided with discharge summary[3]	370 (83)	428 (84)	366 (96)	2168 (83)	2410 (88)	2722 (96)	1093 (84)	1433 (87)	1620 (96)
Carer received training[2]	56 (34)	18 (27)	41 (48)	292 (33)	171 (59)	195 (50)	127 (27)	67 (35)	92 (44)
Carer need for support assessed[2, 4]	21 (50)	28 (40)	54 (64)	129 (50)	175 (55)	240 (62)	58 (60)	85 (41)	108 (52)

GP: general practitioner; [1]different response options over the years and excludes palliative care in 2013; [2]if discharged from hospital; [3]excludes deaths and where not applicable, i.e. discharged to inpatient rehabilitation; [4]question not asked in 2007

5 DISCUSSION

In the Acute Clinical Audit section of the 20-year report, we provide evidence that the quality of acute stroke care has improved in the hospitals that participated in the audits between 2007 and 2017. In particular, we observed that a greater proportion of patients were treated according to the recommendations in national clinical guidelines.[5] Care provided also more often reflected the quality statements in the Acute Stroke Clinical Care Standard,[12] although this comparison was not directly assessed in Part A. This improvement has been facilitated by stroke-related quality improvement activities that have occurred at local, state and national levels. Traditionally national activities have focused on evidence-based clinical practice guideline development and related performance monitoring initiatives with states and hospitals responding to these data through the development of local quality improvement implementation strategies. National level activities have included: promoting the increased establishment of specialised stroke units; developing minimal standards of care and staffing; and achieving consensus on standardised performance measurement.

Thrombolysis is a time-critical therapy that has been shown to be an effective treatment for reducing death and disability from ischaemic stroke.[13] It is recommended that a patient with ischemic stroke, for which treatment is clinically appropriate, be offered this treatment in accordance with clinical guidelines for stroke management[5, 14] where this treatment is clinically appropriate. There is evidence presented in this report that there was an increase in the proportion of patients receiving thrombolysis (from 3% in 2007 to 11% in 2017). This improvement, was potentially influenced by the use of telemedicine, as evidenced by the 2017 thrombolysis rates in rural hospitals in Victoria since the Victorian Stroke Telemedicine program.[15] Nevertheless, only one in ten patients with ischaemic stroke received thrombolysis in the 2017 audit. Wider improvements are required in health services in relation to systems, processes and resources to ensure clinicians are able to offer thrombolysis to all patients who are eligible for this therapy.

Stroke unit care is where specialised stroke care is provided in a dedicated ward and is the single most important clinical guideline recommendation for improving stroke management. Patients treated in a stroke unit are more often provided with evidence-based therapies[16] that reduce the odds of death and disability by about 20%.[17] We found an increase in the proportion of patients being treated in a stroke unit, yet still only two in three patients were treated in a stroke unit in the 2017 audit. Health services need to ensure that there are systems, infrastructure and resources in place for all patients with stroke to be treated in a stroke unit as recommended in the clinical guidelines and Acute Stroke Services Framework.[6]

The improvements seen in the provision of thrombolysis and stroke unit care are possible through concurrent changes in the organisation of services and resources available at hospitals. For example, diagnostic scans are now provided to nearly all patients with stroke, enabling the identification of eligible cases for reperfusion therapies. Also, triage protocols for patients with stroke have been established within emergency departments, and access to telehealth and clinical pathways are being used in the vast majority of hospitals, all with the aim of improving the chances of patients receiving the reperfusion therapies that can only be provided within a short time window.

In this report, we provide evidence that other aspects of acute care delivery have also improved since 2007 in line with clinical guideline recommendations. These include access to timely allied health, involvement of the patient and family in management decisions, education for risk factor management, and support for patients and carers returning to the community. Improvements to the organisation of stroke care and quality of care in hospitals were seen in both rural and urban hospitals, and were consistent across hospitals of different admission volumes. Continued efforts are required to maintain improvements to the organisational services for stroke and it is important that there is continued monitoring of performance in future audits.

The strengths of these audit data are the use of clinical indicators developed through analytical and consensus methods evaluated using a large comprehensive national dataset over many years. There are a number limitations of the audit data that need to be considered. While the audits have participation from the broadest sample of hospitals of any data collection program in Australia, we cannot assume that the audit case series is representative of all patients with stroke. Also, retrospective review of medical records may be hindered by missing data through poor documentation, and other forms of bias associated with the quality of information contained within medical records. To improve data quality, hospital staff underwent training prior to completion of the audits and had access to ongoing support from Stroke Foundation staff during the audit process.

The audit is performed biennially and can only provide a broad overview of changes that have occurred over audit periods. The acute audit data for stroke has been valuable for providing evidence of responses to policy initiatives, audit and feedback, and quality improvement programs (see Part D). However, in order for hospitals to be more responsive to quality improvement processes and individual hospital and patient needs, continuous prospectively collected data and patient-oriented long-term outcome data are also needed. This has been made possible with the development of the Australian Stroke Clinical Registry (AuSCR) in 2009.[18] The AuSCR has expanded from 6 sites in 2009 to 59 hospitals in 2017 with data from Queensland, Victoria, NSW and Tasmania. Plans are underway for expansion to the other states in 2019 including Western Australia and South Australia.This will provide a more comprehensive data set for monitoring acute stroke care, including 90-day patient outcome data.

In summary, we provide evidence in the acute audit section of this report that there have been significant changes in the organisation of stroke care in relation to access to stroke unit care and the provision of thrombolysis. Others aspects of acute care delivery have also improved over the 10-year period in line with clinical guideline recommendations. In the future, it is important that there is continued monitoring of acute care for patients with stroke, and proactive efforts are made to reduce gaps identified in best-practice care.

Part B: National Stroke Audit Rehabilitation Services 2008–2018

PART B NATIONAL STROKE AUDIT REHABILITATION SERVICES 2008-2018

1 BACKGROUND

The first national survey of inpatient rehabilitation stroke services was conducted in 2008 by the Stroke Foundation as part of the National Stroke Audit program. Data for the National Audit program concentrates on the infrastructure of hospitals and processes of care provided specifically for patients with stroke. This is different to the data collected for the Australasian Rehabilitation Outcomes Centre (AROC), which is focussed on outcomes of all patients who receive rehabilitation in Australia. The aims of the National Audit program are to monitor and facilitate improved delivery of evidence-based care for patients with stroke being treated in rehabilitation hospitals. Questions were designed to evaluate adherence to recommendations in the Clinical Guidelines for Stroke Rehabilitation and Recovery.[19] Similar to the acute audit, which was first conducted as part of this program in 2007, the rehabilitation audit comprises two components: an organisational survey for collecting information on service characteristics, and a retrospective clinical medical record audit to collect patient level data on processes of care received during the admission and in-hospital outcomes. The audit continues to be conducted biennially in rehabilitation hospitals in Australia. Questions in subsequent years have been updated or refined to align with the National Rehabilitation Stroke Services Framework[20] and the Clinical Guidelines for Stroke Management,[5] with ongoing input from the Stroke Foundation, a National Advisory Committee, and clinicians collecting the data. The aim of this section of the report is to provide a longitudinal overview of the changes from 2008 to 2018 in rehabilitation hospitals treating patients with stroke in Australia from the perspective of:

- stroke service characteristics and resources, and
- quality of care in hospital.

2 METHODS

Cross-sectional data were collected from hospitals delivering inpatient rehabilitation to patients with stroke that volunteered to participate in the National Stroke Audit program in 2008, 2010, 2012, 2014, 2016 and 2018.

2.1 Sampling methods

The identification of rehabilitation hospitals invited to participate in the surveys and clinical audits varied across the years. Table 42 highlights the sampling methods used for identification of eligible hospitals for each of the audits.

Table 42 Sampling methods for identification of eligible hospitals by audit (2008-2018)

Audit	Recruitment
2008	• Public hospitals in the Australasian Faculty of Rehabilitation Medicine database were invited to participate • Focus was on freestanding rehabilitation hospitals and rehabilitation units within acute hospitals • Audit was also promoted through various stroke clinical networks • No formal mechanism to recruit private hospitals
2010	• Public hospitals with a rehabilitation service were actively targeted via letter of invitation, with follow-up phone calls and emails • Private hospitals identified through the Australasian Rehabilitation Outcomes Centre (AROC) were sent a letter of invitation, but not actively recruited
2012	• Public hospitals with a rehabilitation service were targeted via letter of invitation, with active follow up via phone and email • Private hospitals that previously participated, and additional hospitals identified via the stroke clinical networks, were invited to participate

Audit	Recruitment
2014	• Eligible public and private hospitals with a rehabilitation service were identified via previous participation in the Audit Program, with input from the stroke clinical networks and AROC, and were actively recruited via letter of invitation with follow-up for non-responders
2016	• Public and private hospitals with an inpatient rehabilitation service admitting a least one patient with stroke in the previous year (identified via AROC data) were a focus. Hospitals that had previously participated in the Audit Program were invited, as were other eligible hospitals identified via stroke clinical networks or participation in AROC
2018	• Public and private hospitals with an inpatient rehabilitation service admitting a least five patients with stroke in the previous year (identified via AROC data) were a focus. Hospitals that had previously participated in the Audit Program were invited, as were other eligible hospitals identified via stroke clinical networks or participation in AROC

2.2 Data collection

All self-reported organisational survey data were completed by a knowledgeable clinical representative, such as a stroke coordinator or medical representative from each hospital, with results entered into a web-based data entry tool (DET). For clinical data during this time, clinicians audited up to 40 consecutive medical records of patients with stroke admitted from the year prior to the respective audit period, with data entered directly into the DET. Patients presenting with transient ischaemic attack or subarachnoid haemorrhage were excluded due to different pathways of care. The DET included comprehensive field notes embedded into the system, with inbuilt logic checks. From 2014, hospitals that also submitted data to AROC could import relevant data, e.g. date of admission and discharge, from AROC into the data entry tool to reduce the burden of data collection. From 2016, all organisational and clinical data were collected via the Australian Stroke Data Tool (AuSDaT). Hospitals were assigned an individual hospital code and no patient-identifying data were collected to ensure that all patient data were de-identified. In each audit, participating hospitals were asked to audit the first five patients' clinical notes twice using different auditors to assess the reliability of data abstraction.

2.3 Data analyses

Both public and private hospitals were included in these analyses, as rehabilitation for patients with stroke is more commonly provided in private rehabilitation hospitals. Survey data from 2008, 2010, 2012, 2014, 2016 and 2018 were mapped for consistency to enable reliable comparisons. Relevant service characteristics and resources have been described. Differences in these characteristics over time based on hospital type (public vs private) and annual stroke admissions (volume) were described for the organisational survey data for hospitals participating in the audits in early (2008 and/or 2010), mid (2012 and/or 2014) and late (2016 and/or 2018) periods. Elements of the National Rehabilitation Stroke Services Framework[20] were compared for 2014, 2016 and 2018. Hospitals in metropolitan or large regional areas with a local governance area of greater than or equal to 25,000 people were defined as 'urban', while 'rural' hospitals were considered to be in locations with population size smaller than 25,000.[8] Hospitals reporting 30 or fewer annual stroke admissions were considered small volume hospitals; hospitals with 31 to 79 admissions were considered medium volume hospitals; and those with 80 or more annual stroke admissions were considered large volume hospitals. For select organisational data, random effects logistic regression was performed, with clustering for hospital, to assess the associated between adherence and the audit period. Chi square was performed to determine differences in available services and resources in the recent audit/period based on hospital type and stroke admissions.

For clinical audit data, patient care and in-hospital outcomes from the six audit cycles were mapped for consistency to enable reliable comparisons. Only valid responses were included for questions related to impairments. However, not documented/unknown responses were assumed to be negative and included in the denominator for processes of care. For these processes, descriptive statistics were used to report the frequency and percentages for categorical data and median was used for numerical data. Random effects logistic regression was undertaken and reported as odds ratio (OR) with 95% confidence intervals (CI) to investigate the association between specific clinical processes and differences across audit periods, with clustering within hospitals taken into account. Processes of care data were further stratified by hospital type and stroke admissions (volume) per year.

A matched hospital sample was used to examine differences in patient outcomes over time, including length of stay (LOS), death, disability, and functional independence measure (FIM) efficiency. Data from 74 hospitals that completed the clinical audit in each period were included. Where outcomes were comparable, results were adjusted for factors known to be associated with outcomes: age, sex, stroke type, ability to walk on admission as a surrogate for stroke severity, and geographic location. For LOS and FIM efficiency, a median regression model with bootstrapped estimated

standard errors was used, and random effects logistic regression used for binary outcomes. A p-value < 0.05 was considered to be statistically significant.

Assessment of the differences in hospital infrastructure, services and care provision over time based on geographical location was not performed, since the number of participating hospitals located in rural locations was small.

In this report, the symbol '–' is used in tables to indicate where questions were not asked in a particular year. The sum of individual proportions may not add to 100% due to rounding. Denominators reported in column headings of tables may not be applicable to all processes reported within as many relate to only those eligible to receive the process.

The same researchers involved from the outset of the audit program analysed all data using Stata SE 15.0.[11]

3 RESULTS FROM THE ORGANISATIONAL SURVEYS ACROSS THE YEARS

The following section includes data from all hospitals responding to the organisational survey in any period, and provides a descriptive overview of changes in services and resources at hospitals from 2008 to 2018. Only two private hospitals participated in 2008, while 17 private hospitals completed the organisational survey in 2018. (Table 43). Very few rural hospitals participated in the survey in any audit (Table 44). The number of stroke admissions at hospitals that participated in the audits is shown in Table 45.

Table 43 Type of hospitals participating in the rehabilitation audit (2008-2018)

Type of hospital	2008 N=97 n (%)	2010 N=107 n (%)	2012 N=111 n (%)	2014 N=111 n (%)	2016 N=121 n (%)	2018 N=120 n (%)
Public	95 (98)	92 (86)	98 (88)	96 (86)	104 (86)	103 (86)
Private	2 (2)	15 (14)	13 (12)	15 (14)	17 (14)	17 (14)

Table 44 Geographical location of hospitals participating in the rehabilitation audit (2008-2018)

Geographical location	2008 N=97 n (%)	2010 N=107 n (%)	2012 N=111 n (%)	2014 N=111 n (%)	2016 N=121 n (%)	2018 N=120 n (%)
Urban	92 (95)	100 (93)	104 (94)	106 (95)	114 (94)	114 (95)
Rural	5 (5)	7 (7)	7 (6)	5 (5)	7 (6)	6 (5)

Table 45 Hospital admissions in participating hospitals (2008-2018)

Number of patients with stroke admitted in the last year	2008 N=97 n (%)	2010 N=107 n (%)	2012 N=111 n (%)	2014 N=111 n (%)	2016 N=121 n (%)	2018 N=120 n (%)
30 or fewer	20 (21)	24 (23)	28 (25)	19 (17)	23 (19)	22 (18)
31-79	49 (50)	55 (51)	58 (52)	55 (50)	57 (47)	59 (49)
80+	28 (29)	28 (26)	25 (23)	37 (33)	41 (34)	39 (33)

3.1 Organisational Survey: Results by audit (2008-2018)

3.1.1 Characteristics of the hospitals providing stroke care

In all audits, rehabilitation was most commonly provided in a rehabilitation ward within the same building as the acute hospital, or in a standalone rehabilitation hospital (Table 46). An increase in the median numbers of patients admitted with stroke was noted between 2008 and 2018.

Table 46 Characteristics of hospitals providing rehabilitation services (2008-2018)

	2008 N=97 n (%)	2010 N=107 n (%)	2012 N=111 n (%)	2014 N=111 n (%)	2016 N=121 n (%)	2018 N=120 n (%)
Number of beds dedicated for inpatient rehabilitation (not stroke specific) – median (Q1, Q3)	22 (16, 29)	22 (15, 35)	25 (16, 40)	26 (18, 40)	24 (16, 40)	25 (18, 40)
Type of rehabilitation service[1]						
Freestanding rehabilitation hospital	-	34 (32)	35 (31)	37 (33)	31 (26)	35 (29)
Rehabilitation ward within acute hospital in same building of same health campus	-	54 (50)	53 (48)	57 (51)	68 (56)	63 (53)
Rehabilitation ward within acute hospital in separate buildings of same health campus	-	17 (16)	21 (19)	16 (15)	22 (18)	19 (16)
Rehabilitation service within acute hospital (no designated beds)	-	2 (2)	2 (2)	1 (1)	0 (0)	0 (0)
Comprehensive Stroke Unit[1]	-	-	-	-	-	3 (3)
Patients admitted with stroke in the last year – median (Q1, Q3)	50 (33, 83)	55 (32, 80)	50 (30, 76)	56 (36, 97)	62 (36, 101)	63 (36, 96)

Q1: 1st quartile; Q3: 3rd quartile; [1]added as response option in 2018

3.1.2 Stroke unit access

Table 47 depicts the number of rehabilitation hospitals where prioritised beds for stroke were reported from 2008 to 2018. Care must be taken in the interpretation of these data, as definitions around a 'dedicated stroke rehabilitation unit' changed across the audits, with the questions becoming more specific in 2016 and 2018.

Table 47 Stroke unit access (2008-2018)

	2008 N=97 n (%)	2010 N=107 n (%)	2012 N=111 n (%)	2014 N=111 n (%)	2016 N=121 n (%)	2018 N=120 n (%)
Hospital has dedicated stroke rehabilitation unit	8 (8)	13 (12)	10 (9)	7 (6)	12 (10)[1]	13 (11)[1]
Designated beds if no stroke unit	8 (8)	10 (9)	13 (12)	23 (21)	-	-

[1]in 2016/2018, it was specified that stroke rehabilitation needed to be collocated stroke beds within a geographically defined unit, which was not the case earlier

3.1.3 Stroke team

In all audits, a rehabilitation physician or geriatrician was the medical lead most commonly responsible for management of patients with stroke (Table 48). Very few rehabilitation hospitals had a neurologist as the medical lead. Nearly all hospitals reported having access to physiotherapists, occupational therapists and speech pathologists. In 2018, patients with stroke had greater access to social workers and psychologists when compared to all earlier audits, and dietitians when compared to 2008-2012 audits (Table 48).

Table 48 Access to an interdisciplinary stroke team (2008-2018)

	2008 N=97 n (%)	2010 N=107 n (%)	2012 N=111 n (%)	2014 N=111 n (%)	2016 N=121 n (%)	2018 N=120 n (%)
Medical lead responsible for management of patients with stroke						
Rehabilitation physician	63 (65)	77 (72)	68 (61)	80 (72)	83 (69)	86 (72)
Geriatrician	19 (20)	13 (12)	20 (18)	16 (14)	23 (19)	21 (18)
General medical physician	7 (7)	11 (10)	7 (6)	11 (10)	11 (9)	11 (9)
General practitioner/VMO	7 (7)	4 (4)	12 (11)	2 (2)	2 (2)	1 (1)
Neurologist	1 (1)	2 (2)	4 (4)	2 (2)	2 (2)	1 (1)
Health professionals actively involved in rehabilitation management of patients with stroke[1]						
Physiotherapist	95 (99)	107 (100)	111 (100)	111 (100)	121 (100)	120 (100)
Occupational therapist	96 (100)	106 (99)	110 (99)	111 (100)	121 (100)	120 (100)
Speech pathologist	93 (97)	106 (99)	111 (100)	111 (100)	121 (100)	120 (100)
Dietitian	81 (84)	104 (97)	110 (99)	111 (100)	121 (100)	119 (99)
Social worker	88 (92)	99 (93)	105 (95)	106 (96)	117 (97)	118 (98)
Psychologist[2]	44 (46)	50 (47)	56 (50)	59 (53)	74 (61)	77 (64)
Specialist nurse[3]	-	78 (73)	81 (73)	89 (80)	96 (79)	91 (76)
Allied health assistant/therapy assistant	-	104 (97)	108 (97)	104 (94)	118 (98)	116 (97)

VMO: Visiting Medical Officer; [1]in 2008, question derived from staffing levels for rehabilitation and stroke unit beds; [2]includes psychologist or neuropsychologist in 2008 and in subsequent years includes clinical or neuropsychologist; [3]includes clinical nurse consultant, clinical nurse specialist OR stroke care coordinator

3.1.4 Team communication and ongoing professional development education

The majority of hospitals reported conducting weekly team meetings in all audits (Table 49). Access to ongoing education for staff has improved, with 54% of hospitals reporting that this was offered regularly in 2008, compared to 69% in 2018.

Table 49 Changes in team communication and ongoing education (2008-2018)

	2008 N=97 n (%)	2010 N=107 n (%)	2012 N=111 n (%)	2014 N=111 n (%)	2016 N=121 n (%)	2018 N=120 n (%)
Weekly team meetings	94 (97)	105 (98)	107 (96)	107 (96)	120 (99)	120 (100)
Program for continuing education of staff	52 (54)	59 (55)	75 (68)	68 (61)	79 (65)	83 (69)

3.1.5 Goal setting and therapy provided

The question relating to formal processes for developing and documenting goals with patients changed from the initial audit in 2008, therefore, direct comparison with 2008 data requires caution. A greater proportion of hospitals reported having formal means to address these processes in 2016 (88%) compared to 2010 (76%), however, this reduced slightly in the most recent audit (Figure 21). Having goals discussed and reviewed at the team meeting after individual interviews by team members was the most common means of setting goals in all periods (Table 50). Over time, more hospitals reported having the patient and full multidisciplinary team set goals together (2010: 14%, 2018: 23%). In 2018, three-quarters of hospitals provided group circuit classes. Prior to this time, there was an increase in hospitals providing general group therapy (2010: 80%, 2016: 94%). Even prior to the question changes in 2018 relating to the amount of time patients undertake active physical therapy, there was variation across the audits in hospitals that reported patients undertook at least one hour of active physical therapy per day.

Table 50 Goal setting processes and therapy provided (2008-2018)

	2008 N=97 n (%)	2010 N=107 n (%)	2012 N=111 n (%)	2014 N=111 n (%)	2016 N=121 n (%)	2018 N=120 n (%)
Formal processes in place for developing and documenting goals with patients	89 (92)[1]	81 (76)	91 (82)	90 (81)	107 (88)	102 (85)
Patient-directed goals usually established:						
Patient interviewed by each discipline separately	-	8 (7)	7 (6)	6 (5)	10 (8)	9 (8)
Goals discussed and reviewed at team meeting after patient meets with each discipline separately	-	70 (65)	82 (74)	78 (70)	72 (60)	74 (62)
Patient and full multidisciplinary team set goals together	-	15 (14)	15 (14)	14 (13)	25 (21)	27 (23)
Ad hoc (no consistent processes used)	-	9 (8)	5 (5)	8 (7)	6 (5)	7 (6)
Goals are not patient-directed	-	0 (0)	0 (0)	1 (1)	0 (0)	0 (0)
Other[2]	-	5 (5)	2 (2)	4 (4)	8 (7)	3 (3)
Patient-directed goals set with team and patient[3]	-	85 (79)	97 (87)	92 (83)	97 (80)	101 (84)
Provides group therapy	-	86 (80)	97 (87)	95 (86)	114 (94)	92 (77)[4]
Patients with motor impairments undertake at least one hour of active physical therapy per day	-	-	108 (97)	108 (97)	112 (93)	83 (69)[5]

[1]question in 2008 was 'formal process for goal setting', therefore did not relate directly to patients; [2]'Other' included goal setting with a key contact and patient, or combination of goal setting methods; [3]goals discussed/reviewed at team meeting after patient meets with each discipline OR patient and full multidisciplinary team set goals together; [4]question changed in 2018 to 'provides group circuit classes'; [5]responses changed from yes/no to categorical options of times in 2018, e.g. <1 hour, >3 hours.

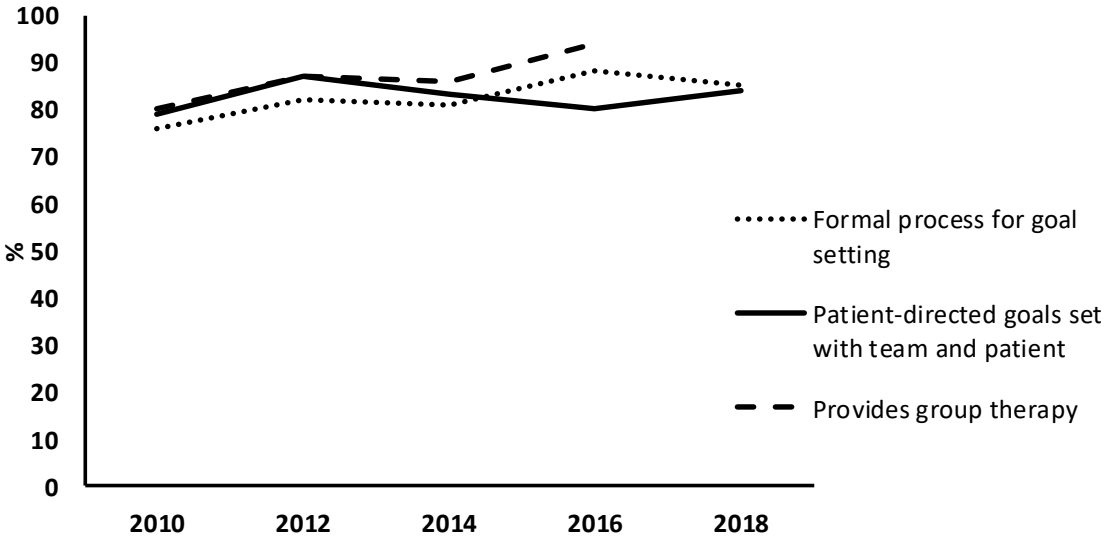


Figure 21 Changes in adherence to goal setting processes (2010-2018)

3.1.6 Discharge planning processes

An increase in the proportion of hospitals using protocols to guide discharge planning, and those providing patients with a discharge care plan, was evident from 2010 to 2018 (Table 51). However, these processes were still not occurring in 2018 at two in five hospitals. A greater proportion of hospitals were providing contact details post discharge in recent years (2010: 58%, 2018: 82%), and although variability was evident in hospitals that provided patient education prior to discharge, this was generally quite high (89% in 2014, 98% in 2018) (Figure 22).

Table 51 Discharge planning processes (2008-2018)

	2008 N=97 n (%)	2010 N=107 n (%)	2012 N=111 n (%)	2014 N=111 n (%)	2016 N=121 n (%)	2018 N=120 n (%)
Protocols in place guiding discharge planning for stroke rehabilitation patients	-	55 (51)	58 (52)	57 (51)	63 (52)	74 (62)
Patients routinely given a discharge care plan on discharge from hospital	-	53 (50)	56 (50)	56 (50)	65 (54)	81 (68)
Patients and/or carers given details of a hospital contact on transfer from hospital to community	55 (57)[1]	62 (58)	65 (59)	64 (58)	91 (75)	98 (82)
Patient education routinely provided prior to discharge	-	105 (98)	106 (96)	99 (89)	116 (96)	117 (98)

[1]derived from open text responses in 2008

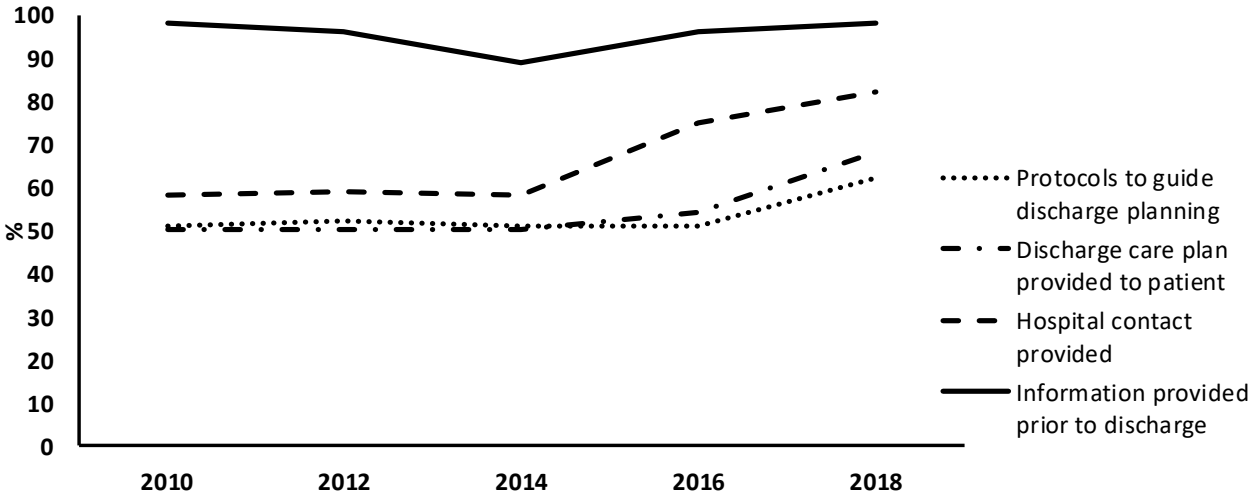


Figure 22 Changes in adherence to discharge planning processes (2010-2018)

3.1.7 Access to further rehabilitation

From 2008 to 2016, access to centre-based and community-based rehabilitation increased (Table 52). The questions were changed in 2018 to refer to hospitals that actually provided these services, so the 2018 data were not comparable to the earlier audits. Access to early supported discharge services was variable across the years despite the question changes, with 47% of hospitals in 2018 reporting that they provide a 'stroke specific' early supported discharge service.

Table 52 Community rehabilitation services (2008-2018)

	2008 N=97 n (%)	2010 N=107 n (%)	2012 N=111 n (%)	2014 N=111 n (%)	2016 N=121 n (%)	2018 N=120 n (%)
Community rehabilitation services[1]	**'Access to'**					**'Provided'**
Centre-based rehabilitation (e.g. outpatient rehabilitation or day hospital)	83 (86)	98 (92)	101 (91)	107 (96)	116 (96)	105 (88)
Community-based rehabilitation provided in the home	65 (67)	74 (69)	82 (74)	75 (68)	105 (87)	72 (60)
Early Supported Discharge	33 (34)	27 (25)	30 (27)	29 (26)	21 (17)[2]	56 (47)[2]

[1]From 2008 to 2016, the questions related to hospitals having access to these services, whereas in 2018, questions changed to hospitals actually providing these services; [2]question changed to 'stroke specific' early supported discharge in 2016/2018

3.2 Organisational Survey: Comparisons by hospital type (public versus private)

The following section provides a descriptive overview of changes in service characteristics and resources in all public and private hospitals providing rehabilitation to patients with stroke in the early (2008, 2010), mid (2012, 2014) and late (2016, 2018) periods.

3.2.1 Stroke unit access

Only one private hospital in each period reported having a dedicated stroke rehabilitation unit (Table 53). Although the proportion of public hospitals with a stroke rehabilitation unit has not changed over the periods, it is difficult to compare since the definition for a 'dedicated stroke rehabilitation unit' changed between audits.

Table 53 Changes in access to dedicated stroke beds by hospital type (early, mid, late periods)

	Public			Private		
	Early N=187 n (%)	Mid N=194 n (%)	Late N=207 n (%)	Early N=17 n (%)	Mid N=28 n (%)	Late N=34 n (%)
Hospital has dedicated stroke rehabilitation unit	20 (11)	16 (8)	24 (12)[1]	1 (6)	1 (4)	1 (3)[1]
Designated beds if no stroke unit	16 (9)	34 (18)	-	2 (12)	2 (7)	-

[1]In 2016/2018, it was specified that a stroke rehabilitation unit needed to be collocated stroke beds within a geographically defined unit. This was not the case in earlier periods.

3.2.2 Stroke Team

No private hospitals providing stroke rehabilitation services reported having access to neurologists in any period (Table 54). Rehabilitation physicians were most commonly the medical lead, regardless of public/private status. Access to physiotherapists, occupational therapists, speech pathologists and allied health assistants was almost universal in all periods, for both public and private hospitals. However, access to social workers was less common in private hospitals (late period: public - 100%, private - 85%). Improvements in access to psychologists (clinical or neuropsychologists) were evident over the periods, regardless of hospital type. There was variability in access to specialist nurses. Although there appeared to be greater access in public hospitals compared to private in the late period, this was not statistically different.

Table 54 Changes in access to the interdisciplinary stroke team by hospital type (early, mid, late periods)

	Public			Private		
	Early N=187 n (%)	Mid N=194 n (%)	Late N=207 n (%)	Early N=17 n (%)	Mid N=28 n (%)	Late N=34 n (%)
Medical lead responsible for management of patients with stroke						
Rehabilitation physician	128 (68)	124 (64)	140 (68)	12 (71)	24 (86)	29 (85)
Geriatrician	28 (15)	32 (16)	39 (19)	4 (24)	4 (14)	5 (15)
General medical physician	17 (9)	18 (9)	22 (11)	1 (6)	0 (0)	0 (0)
General practitioner/VMO	11 (6)	14 (7)	3 (1)	0 (0)	0 (0)	0 (0)
Neurologist	3 (2)	6 (3)	3 (1)	0 (0)	0 (0)	0 (0)
Health professionals actively involved in rehabilitation management of patients with stroke[1]						
Physiotherapist	185 (99)	194 (100)	207 (100)	17 (100)	28 (100)	34 (100)
Occupational therapist	185 (99)	193 (99)	207 (100)	17 (100)	28 (100)	34 (100)
Speech pathologist	182 (98)	194 (100)	207 (100)	17 (100)	28 (100)	34 (100)
Dietitian	168 (90)	193 (99)	206 (100)	17 (100)	28 (100)	34 (100)
Social worker	176 (95)	191 (98)	206 (100)	11 (65)	20 (71)	29 (85)
Psychologist[2]	85 (46)	99 (51)	128 (62)	9 (53)	16 (57)	23 (68)
Specialist nurse[3]	66 (72)[4]	151 (78)	164 (79)	12 (80)[4]	19 (68)	23 (68)
Allied health assistant/therapy assistant	89 (97)[4]	184 (95)	200 (97)	15 (100)[4]	28 (100)	34 (100)

VMO: Visiting Medical Officer; [1]in 2008, the question was derived from staffing levels for rehabilitation and stroke unit beds; [2]includes psychologist or neuropsychologist in 2008 and in subsequent years includes clinical or neuropsychologist; [3]includes clinical nurse consultant, clinical nurse specialist OR stroke care coordinator; [4]not asked in 2008, so only 2010 figures are reflected

3.2.3 Team communication and ongoing professional development education

Team meetings occurred weekly at the majority of hospitals regardless of hospital type (Table 55). Similarly, continuing education was available at more hospitals in the late period compared to earlier, with no difference in the proportion of hospitals that offered this program for staff in 2016/2018 based on hospital type.

Table 55 Changes in access to team communication and ongoing education by hospital type (early, mid, late periods)

	Public			Private		
	Early N=187 n (%)	Mid N=194 n (%)	Late N=207 n (%)	Early N=17 n (%)	Mid N=28 n (%)	Late N=34 n (%)
Weekly team meetings	182 (97)	186 (96)	206 (100)	17 (100)	28 (100)	34 (100)
Program for continuing education of staff	103 (55)	123 (63)	138 (67)	8 (47)	20 (71)	24 (71)

3.2.4 Discharge planning processes

Just over half of the public hospitals reported using protocols to guide discharge in the late period, and this was relatively unchanged compared to the earlier periods (Table 56 and Figure 23a). However, in private hospitals, this process improved over the periods (early: 33%, mid: 61%, late: 65%). An increase in the proportion of hospitals routinely providing discharge care plans and those providing hospital contact details on discharge was seen over the periods, regardless of hospital type (Figure 23b and c). Descriptively, private hospitals appeared more likely to provide care plans than public hospitals in the late period, however, this difference was not significant. A large proportion of public and private hospitals routinely provided information prior to discharge across all periods.

Table 56 Changes in discharge planning processes by hospital type (early, mid, late periods)

	Public			Private		
	Early N=187 n (%)	Mid N=194 n (%)	Late N=207 n (%)	Early N=17 n (%)	Mid N=28 n (%)	Late N=34 n (%)
Protocols in place guiding discharge planning for stroke rehabilitation patients	50 (54)[1]	98 (51)	115 (56)	5 (33)[1]	17 (61)	22 (65)
Patients routinely given a discharge care plan on discharge from hospital	44 (48)[1]	95 (49)	121 (58)	9 (60)[1]	17 (61)	25 (74)
Patients and/or carers given details of a hospital contact on transfer from hospital to community	109 (58)[2]	113 (58)	159 (77)	8 (47)[2]	16 (57)	30 (88)
Patient education routinely provided prior to discharge	91 (99)[1]	178 (92)	199 (96)	14 (93)[1]	27 (96)	34 (100)

[1] Question not asked in 2008; [2]derived from open text responses in 2008

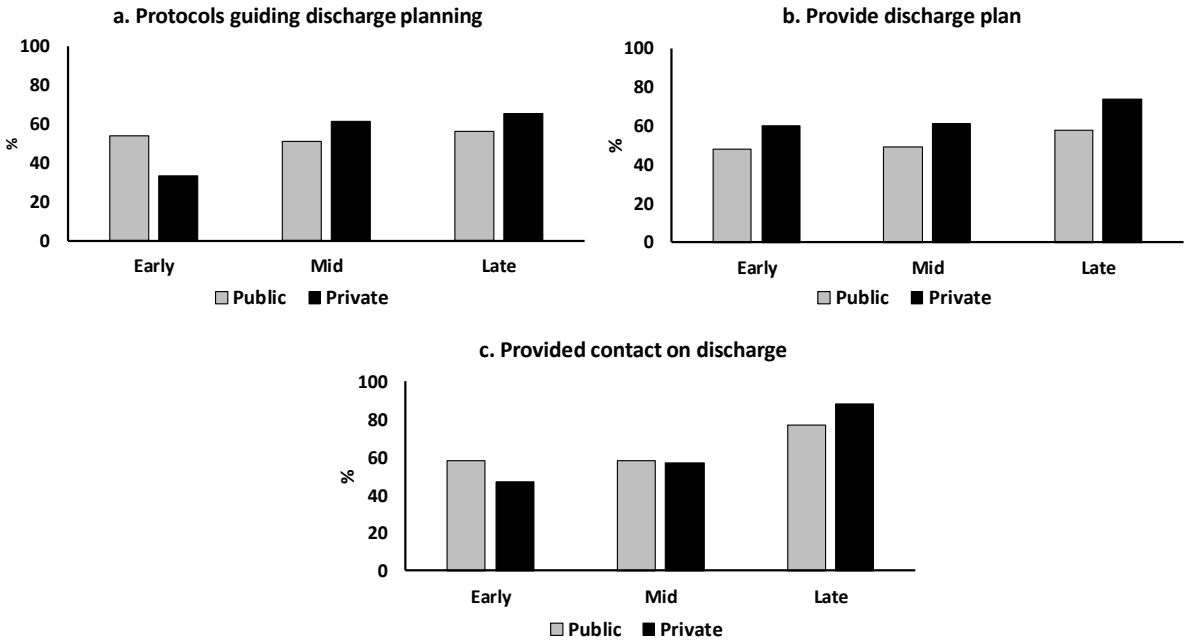


Figure 23 Changes in access to discharge planning processes by hospital type (early, mid, late periods)

3.3 Organisational Survey: Comparisons by annual stroke admission volume

The following section provides a descriptive overview of changes in adherence from 2008 to 2018 by hospital volume, which was determined by annual stroke admissions (small volume: 30 or fewer admissions, medium: 31 to 79 admissions, and large: 80 or more admissions).

3.3.1 Stroke unit access

Although it is difficult to compare directly, minimal changes in access to dedicated stroke rehabilitation units were evident over the periods, regardless of admission numbers (Table 57).

Table 57 Changes in access to dedicated stroke beds by hospital volume (early, mid, late periods)

Stroke volume	Small (≤30 admissions)			Medium (31-79 admissions)			Large (80+ admissions)		
	Early N=44 n (%)	Mid N=47 n (%)	Late N=45 n (%)	Early N=104 n (%)	Mid N=113 n (%)	Late N=116 n (%)	Early N=56 n (%)	Mid N=62 n (%)	Late N=80 n (%)
Hospital has dedicated stroke rehabilitation unit	2 (5)	0 (0)	3 (7)[1]	7 (7)	5 (4)	6 (5)[1]	12 (21)	12 (19)	16 (20)[1]
Designated beds if no stroke unit	2 (5)	4 (9)	-	9 (9)	13 (12)	-	7 (13)	19 (31)	-

[1]In 2016/2018, it was specified that stroke rehabilitation needed to be collocated stroke beds within a geographically defined unit, which was not the case earlier

3.3.2 Team communication and ongoing professional development education

The majority of hospitals, regardless of admission numbers, conducted weekly team meetings in all periods (Table 58). An increase in the proportion of hospitals offering continuing education for staff was seen for all hospital volumes from the early to late period. However, in the late period, a greater proportion of large volume hospitals (80+ admissions) provided ongoing education compared to medium and smaller volume hospitals (small: 56%, medium: 62%, large: 81%, p<0.01).

Table 58 Changes in access to team communication and ongoing education by hospital volume (early, mid, late periods)

Stroke volume	Small (≤30 admissions)			Medium (31-79 admissions)			Large (80+ admissions)		
	Early N=44 n (%)	Mid N=47 n (%)	Late N=45 n (%)	Early N=104 n (%)	Mid N=113 n (%)	Late N=116 n (%)	Early N=56 n (%)	Mid N=62 n (%)	Late N=80 n (%)
Weekly team meetings	43 (98)	45 (96)	45 (100)	102 (98)	110 (97)	115 (99)	54 (96)	59 (95)	80 (100)
Program for continuing education of staff	17 (39)	23 (49)	25 (56)	55 (53)	76 (67)	72 (62)	39 (70)	44 (71)	65 (81)

3.3.3 Discharge planning processes

The proportion of hospitals where patient information was routinely provided prior to discharge remained ≥ 90% over all periods, regardless of stroke admission volume (Figure 24d). Increases were evident regardless of hospital volume related to the provision of contact details on discharge (Figure 24c). However, in all hospitals, variability was seen over the periods in the reported use of protocols to guide discharge planning, and use of discharge care plans (Table 59 and Figure 24a/c), Overall, in the late period, no difference was seen in adherence to these aspects based on volume.

Table 59 Changes in discharge planning processes by hospital volume (early, mid, late periods)

Stroke volume	Small (≤30 admissions)			Medium (31-79 admissions)			Large (80+ admissions)		
	Early N=44 n (%)	Mid N=47 n (%)	Late N=45 n (%)	Early N=104 n (%)	Mid N=113 n (%)	Late N=116 n (%)	Early N=56 n (%)	Mid N=62 n (%)	Late N=80 n (%)
Protocols in place guiding discharge planning for stroke rehabilitation patients	15 (63)[1]	19 (40)	23 (51)	24 (44)[1]	66 (58)	60 (52)	16 (57)[1]	30 (48)	54 (68)
Patients routinely given a discharge care plan on discharge from hospital	13 (54)[1]	32 (68)	24 (53)	28 (51)[1]	50 (44)	70 (60)	12 (43)[1]	30 (48)	52 (65)
Patients and/or carers given details of a hospital contact on transfer from hospital to community	26 (59)[2]	31 (66)	32 (71)	57 (55)[2]	63 (56)	94 (81)	34 (61)[2]	35 (56)	63 (79)
Patient information routinely provided prior to discharge	24 (100)[1]	43 (91)	44 (98)	53 (96)[1]	106 (94)	111 (96)	28 (100)[1]	56 (90)	78 (98)

[1]question not asked in 2008; [2]derived from open text responses in 2008

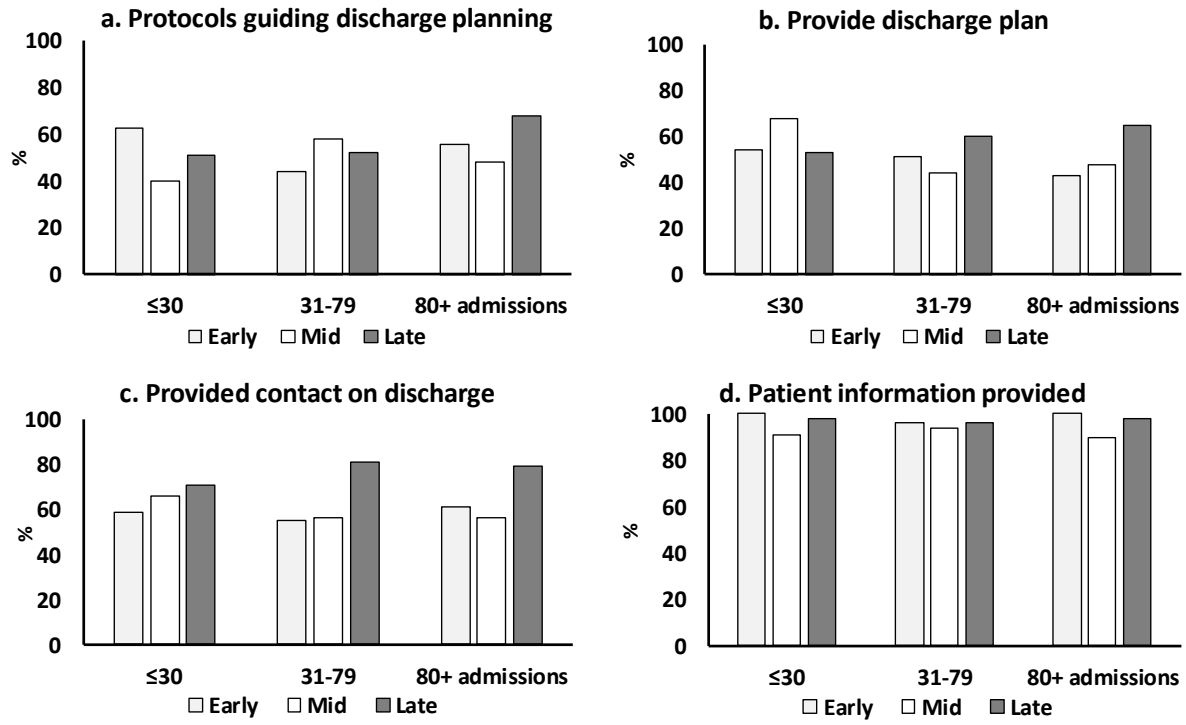


Figure 24 Changes in access to discharge planning processes by hospital volume (early, mid, late periods)

3.4 Organisational Survey: Urban versus rural comparisons for access to interdisciplinary team staff

Access to interdisciplinary stroke team members at rural and urban locations over the periods is presented below. Care must be taken with the interpretation of these results, especially for the early period where some questions were not asked in 2008 and because hospital numbers are quite small.

In rural locations, fewer rehabilitation physicians, and a larger proportion of general medical physicians and general practitioner/visiting medical officers, were responsible for management of patients with stroke compared to urban locations (Table 60). In the late period, similarities were evident in access to certain allied health professions including physiotherapists, occupational therapists, speech pathologists, dietitians, specialist nurses and assistants. However, in rural hospitals compared to urban, access to social workers ($p<0.001$) and psychologists ($p=0.02$) was less common.

Table 60 Changes in access to the interdisciplinary stroke team by geographical location (early, mid, late periods)

	Urban			Rural		
	Early N=192 n (%)	Mid N=210 n (%)	Late N=228 n (%)	Early N=12 n (%)	Mid N=12 n (%)	Late N=13 n (%)
Medical lead responsible for management of patients with stroke						
Rehabilitation physician	137 (71)	147 (70)	165 (72)	3 (25)	1 (8)	4 (31)
Geriatrician	30 (16)	34 (16)	41 (18)	2 (17)	2 (17)	3 (23)
General medical physician	14 (7)	15 (7)	18 (8)	4 (33)	3 (25)	4 (31)
General practitioner/VMO	8 (4)	8 (4)	1 (<1)	3 (25)	6 (50)	2 (15)
Neurologist	3 (2)	6 (3)	3 (1)	0 (0)	0 (0)	0 (0)
Health professionals actively involved in rehabilitation management of patients with stroke[1]						
Physiotherapist	190 (99)	210 (100)	228 (100)	12 (100)	12 (100)	13 (100)
Occupational therapist	191 (100)	210 (100)	228 (100)	11 (92)	11 (92)	13 (100)
Speech pathologist	187 (98)	210 (100)	228 (100)	12 (100)	12 (100)	13 (100)
Dietitian	174 (91)	209 (100)	227 (100)	11 (92)	12 (100)	13 (100)
Social worker	176 (92)	201 (96)	224 (98)	11 (92)	10 (83)	11 (85)
Psychologist[2]	93 (49)	114 (54)	147 (64)	1 (8)	1 (8)	4 (31)
Specialist nurse[3]	72 (72)[4]	165 (79)	177 (78)	6 (86)[4]	5 (42)	10 (77)
Allied health assistant/therapy assistant	98 (98)[4]	200 (95)	221 (97)	6 (86)[4]	12 (100)	13 (100)

VMO: Visiting Medical Officer; [1]in 2008, question derived from staffing levels for rehabilitation and stroke unit beds; [2]includes psychologist or neuropsychologist in 2008 and in subsequent years includes clinical or neuropsychologist; [3]includes clinical nurse consultant, clinical nurse specialist OR stroke care coordinator; [4]not asked in 2008, therefore based on 2010 data only

3.5 Organisational Survey: Adherence to the Rehabilitation Stroke Services Framework (2014-2018)

In the following section, adherence to elements of the Rehabilitation Stroke Services Framework[20] is reported. Questions from the organisational survey were mapped to the Framework elements from 2014 onwards.

Overall, there was an increased adherence to all elements of the Framework (Table 61) from 2014 to 2018. However, even in the 2018 audit, particular elements including access to stroke specific beds, and systems for transfer of care and follow-up for patients, were only being provided in 12% and 39% of hospitals, respectively.

Table 61 Adherence to the Framework elements (2014-2018)

	2014 N=111 n (%)	2016 N=121 n (%)	2018 N=120 n (%)
Effective links with acute stroke service providers	68 (61)	80 (66)	85 (71)
Specialised interdisciplinary stroke (or neuro-rehabilitation) team with access to staff education and professional development specific to stroke	66 (59)	74 (61)	78 (65)
Co-located stroke beds within a geographically defined unit	7 (6)[1]	12 (10)	13 (11)
Standardised and early assessment for neuro-rehabilitation	48 (43)	69 (57)	75 (63)
Written rehabilitation goal setting processes with patients	81 (73)	89 (74)	93 (78)
Routine use of evidence-based guidelines to inform evidence-based therapy for clinicians	76 (68)[2]	68 (56)	79 (66)
Best practice and evidence-based intensity of therapy for goal related activity with patients	63 (57)	62 (51)	82 (68)
Systems for transfer of care, follow-up and re-entry for patients	29 (26)	35 (29)	46 (38)
Support for the person with stroke and carer to maximise community participation and long-term recovery	48 (43)	61 (50)	78 (65)
Systems that support quality improvement, i.e. regular review of local audit data by the stroke team to prioritise and drive stroke care improvement	84 (76)[2]	91 (75)	101 (84)

[1]Change to definition of stroke rehabilitation unit question in 2014 means this element is not directly comparable to 2016/2018 data; [2]caution with question change to this element from 2014 to 2016

Figure 25 depicts the number of elements met in 2014, 2016 and 2018. A significant increase in hospitals meeting eight or more elements was evident in 2018 compared to prior audits (2014: 14%, 2016: 17%, 2018: 35%, p<0.001), and fewer hospitals met less than five elements in the most recent audit compared to 2014 and 2016 (2014: 41%, 2016: 41%, 2018: 28%, p=0.03).

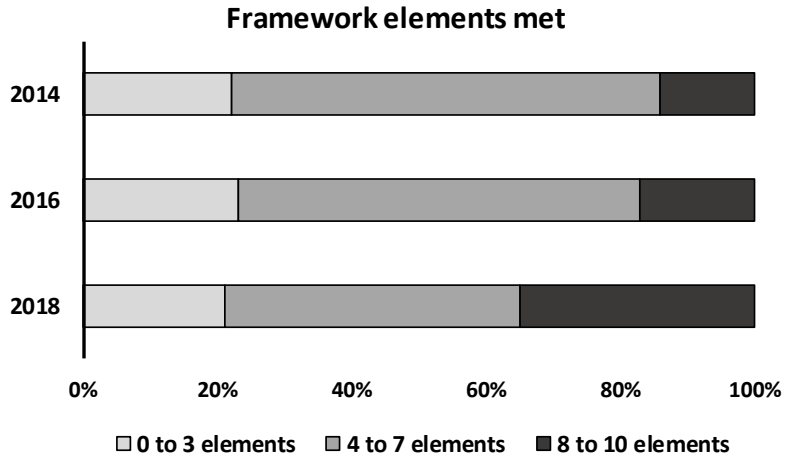


Figure 25 Number of Framework elements met (2014-2018)

3.6 Organisational Survey: Adherence to the Framework by hospital type (2014-2018)

Adherence to the Rehabilitation Framework elements was also reported for public and private hospitals. In the 2018 audit, private hospitals performed better than public hospitals in five elements, and public hospitals performed better than private hospitals in four elements (Table 62), although only 'practice and evidence-based intensity of therapy for goal related activity' was significantly different (p=0.014).

Although, descriptively, a larger proportion of public and private hospitals met 8-10 elements in 2018 compared to earlier audits (Figure 26), the change was only significant in public hospitals (OR 1.8, 95% CI 1.4, 2.4). In public hospitals a similar proportion met 0-3 elements over the audits, with the main change being a shift from meeting 4-7 elements to meeting 8-10 elements (Figure 26).

Table 62 Adherence to Framework elements by hospital type (2014-2018)

	Public			Private		
	2014 N=96 n (%)	2016 N=104 n (%)	2018 N=103 n (%)	2014 N=15 n (%)	2016 N=17 n (%)	2018 N=17 n (%)
Effective links with acute	59 (61)	67 (64)	73 (71)	9 (60)	13 (76)	12 (71)
Specialised interdisciplinary stroke team with access to staff education and professional development	58 (60)	63 (61)	69 (67)	8 (53)	11 (65)	9 (53)
Co-located stroke beds within a geographically defined unit	7 (7)[1]	12 (12)	12 (12)	0 (0)[1]	0 (0)	1 (6)
Standardised and early assessment	42 (44)	59 (57)	66 (64)	6 (40)	10 (59)	9 (53)
Written goal setting processes with patients	68 (71)	73 (70)	78 (76)	13 (87)	16 (94)	15 (88)
Routine use of evidence-based guidelines to inform evidence-based therapy	62 (65)[2]	54 (52)	65 (63)	14 (93)[2]	14 (82)	14 (82)
Best practice and evidence-based intensity of therapy for goal related activity	51 (53)	49 (47)	66 (64)	12 (80)	13 (76)	16 (94)
Systems for transfer of care, follow-up and re-entry for patients	25 (26)	29 (28)	40 (39)	4 (27)	6 (35)	6 (35)
Support for the person with stroke and carer	40 (42)	49 (47)	66 (64)	8 (53)	12 (71)	12 (71)
Systems that support quality improvement	72 (75)[2]	79 (76)	86 (84)	12 (80)[2]	12 (71)	15 (88)

[1]Change to the definition of a stroke rehabilitation unit in 2016/2018 means this element in 2014 is not directly comparable to 2016/2018 data; [2]interpret with caution due to question change to this element in 2016

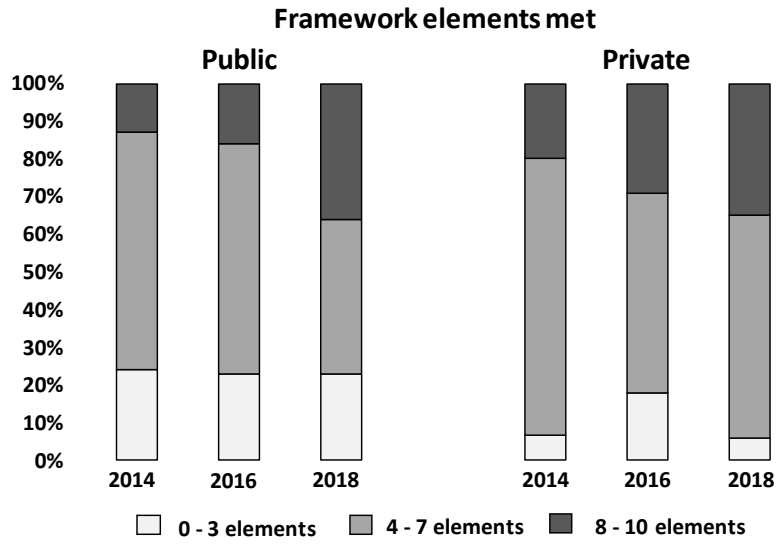


Figure 26 Changes in Framework elements met by hospital type (2014-2018)

3.7 Organisational Survey: Adherence to the Framework by annual stroke admission volume (2014-2018)

Descriptively, adherence to many of the individual elements was greater in large compared to small volume hospitals in 2018 (Table 63). However, only access to 'interdisciplinary team' and 'systems that support quality improvement' were significantly improved. A significant increase was evident in the proportion of hospitals that met 8-10 elements over all audits for medium and large hospital volumes (Figure 27). In the most recent audit, large volume hospitals provided more of the elements compared to medium and small volume hospitals.

Table 63 Adherence to Framework elements by hospital volume (2014-2018)

Stroke volume	Small (≤30 admissions)			Medium (31-79 admissions)			Large (80+ admissions)		
	2014 N=19 n (%)	2016 N=23 n (%)	2018 N=22 n (%)	2014 N=55 n (%)	2016 N=57 n (%)	2018 N=59 n (%)	2014 N=37 n (%)	2016 N=41 n (%)	2018 N=39 n (%)
Effective links with acute	8 (42)	16 (70)	16 (73)	37 (67)	39 (68)	43 (73)	23 (62)	25 (61)	26 (67)
Specialised interdisciplinary stroke team with access to staff education and professional development	8 (42)	12 (52)	11 (50)	33 (60)	32 (56)	36 (61)	25 (68)	30 (73)	31 (79)
Co-located stroke beds within a geographically defined unit	0 (0)[1]	2 (9)	1 (5)	0 (0)[1]	2 (4)	4 (7)	7 (19)[1]	8 (20)	8 (21)
Standardised and early assessment	4 (21)	13 (57)	13 (59)	24 (44)	31 (54)	32 (54)	20 (54)	25 (61)	30 (77)
Written goal setting processes with patients	15 (79)	16 (70)	16 (73)	39 (71)	42 (74)	44 (75)	27 (73)	31 (76)	33 (85)
Routine use of evidence-based guidelines to inform evidence-based therapy	11 (58)[2]	13 (57)	15 (68)	42 (76)[2]	29 (51)	34 (58)	23 (62)[2]	26 (63)	30 (77)
Best practice and evidence-based intensity of therapy for goal related activity	12 (63)	13 (57)	14 (64)	32 (58)	28 (49)	40 (68)	19 (51)	21 (51)	28 (72)
Systems for transfer of care, follow-up and re-entry for patients	4 (21)	6 (26)	6 (27)	12 (22)	15 (26)	22 (37)	13 (35)	14 (34)	18 (46)
Support for the person with stroke and carer	8 (42)	10 (43)	13 (59)	21 (38)	30 (53)	37 (63)	19 (51)	21 (51)	28 (72)
Systems that support quality improvement	12 (63)[2]	18 (78)	16 (73)	41 (75)[2]	37 (65)	47 (80)	31 (84)[2]	36 (88)	38 (97)

[1]Change to definition of stroke rehabilitation unit question in 2014 means this element is not directly comparable to 2016/2018 data;
[2]caution with question change to this element from 2014 to 2016

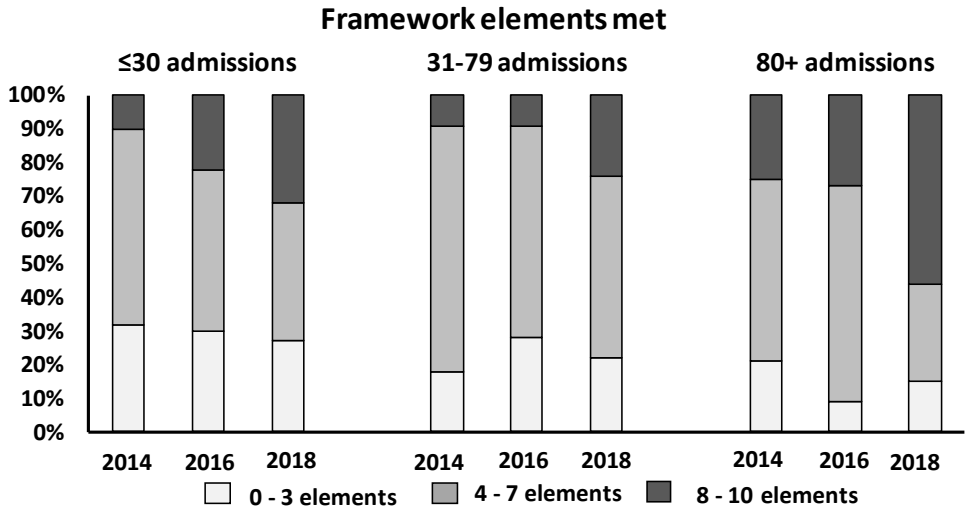


Figure 27 Changes in Framework elements met by hospital volume (2014-2018)

4 RESULTS FROM THE CLINICAL AUDITS OF PATIENTS ACROSS THE YEARS

4.1 Clinical Audit: Progress report over ten years (2008-2018)

Except for 2008, 12-15% of the hospitals that completed the clinical audit were private hospitals, contributing 10-13% of the audit data (Table 64). Similar to participation in the organisational survey, less than 5% of the hospitals were from rural locations (Table 65).

Table 64 Type of hospital that participated in the clinical audit (2008-2018)

	2008		2010		2012		2014		2016		2018	
	Hospitals n (%)	Cases n (%)	Hospitals n (%)	Cases n (%)	Hospitals n (%)	Cases n (%)	Hospitals n (%)	Cases n (%)	Hospitals n (%)	Cases n (%)	Hospitals n (%)	Cases n (%)
Public	67 (99)	2097 (99)	82 (85)	2611 (87)	89 (88)	2542 (90)	91 (88)	2732 (89)	93 (86)	3069 (87)	95 (87)	3246 (89)
Private	1 (1)	22 (1)	15 (15)	374 (13)	12 (12)	279 (10)	12 (12)	349 (11)	15 (14)	445 (13)	14 (13)	405 (11)
Total	68	2119	97	2985	101	2821	103	3081	108	3514	109	3651

Table 65 Geographical location of hospitals and number of cases audited (2008-2018)

	2008		2010		2012		2014		2016		2018	
	Hospitals n (%)	Cases n (%)	Hospitals n (%)	Cases n (%)	Hospitals n (%)	Cases n (%)	Hospitals n (%)	Cases n (%)	Hospitals n (%)	Cases n (%)	Hospitals n (%)	Cases n (%)
Urban	64 (94)	2046 (97)	93 (96)	2885 (97)	95 (94)	2732 (97)	98 (95)	2966 (96)	101 (94)	3361 (96)	104 (95)	3508 (96)
Rural	4 (6)	73 (3)	4 (4)	100 (3)	6 (6)	89 (3)	5 (5)	115 (4)	7 (6)	153 (4)	5 (5)	143 (4)

Approximately half of the hospitals participating in the clinical audit admitted 31-79 patients with stroke annually in each period (Table 66). Over time, fewer small hospitals participated (≤30 admissions), and a greater proportion of hospitals admitting 80 or more patients with stroke annually participated.

Table 66 Stroke rehabilitation patients admitted in the previous year (2008-2018)

	2008		2010		2012		2014		2016		2018	
	Hospitals n (%)	Cases n (%)	Hospitals n (%)	Cases n (%)	Hospitals n (%)	Cases n (%)	Hospitals n (%)	Cases n (%)	Hospitals n (%)	Cases n (%)	Hospitals n (%)	Cases n (%)
≤ 30[1]	15 (22)	272 (13)	21 (22)	362 (12)	25 (25)	415 (15)	18 (17)	285 (9)	19 (18)	365 (10)	20 (18)	404 (11)
31-79[1]	34 (50)	1080 (51)	51 (52)	1743 (58)	52 (51)	1594 (57)	51 (50)	1627 (53)	53 (49)	1833 (52)	53 (49)	1853 (51)
80+[1]	19 (28)	767 (36)	25 (26)	880 (29)	24 (24)	812 (29)	34 (33)	1169 (38)	36 (33)	1316 (37)	36 (33)	1394 (38)

[1]annual stroke admissions reported

4.1.1 Patient demographics

The baseline patient demographics, stroke types, independence prior to admission, and functional status on admission from 2008-2018 are presented in Table 67. Median age was similar, however, there was a greater proportion of patients aged 85 years or older in the 2018 audit compared to 2008. Just over half of the patients in each audit were men. A similar proportion of patients suffered an intracerebral haemorrhage across audits. An increased number of 'other stroke types' was recorded in 2018, with fewer ischaemic strokes. There was a larger proportion of more dependent patients (i.e. those with FIM scores of 18-60) in the 2018 audit compared to earlier audits. However, care must be taken with the interpretation of the FIM scores because there were large amounts of missing data (> 20%) for this variable in 2008, 2010 and 2012.

Table 67 Patient demographics in all audits (2008-2018)

	2008 N=2119 n (%)	2010 N=2985 n (%)	2012 N=2821 n (%)	2014 N=3081 n (%)	2016 N=3514 n (%)	2018 N=3651 n (%)
Age, years						
<65	572 (27)	765 (26)	671 (24)	683 (22)	836 (24)	789 (22)
65-74	498 (24)	651 (22)	688 (24)	724 (24)	803 (23)	896 (25)
75-84	693 (33)	1014 (34)	928 (33)	1037 (34)	1111 (32)	1185 (32)
85+	338 (16)	555 (19)	534 (19)	637 (21)	764 (22)	781 (21)
Age - median (Q1, Q3)	75 (64, 82)	76 (65, 83)	76 (66, 83)	76 (66, 84)	76 (66, 84)	76 (66, 83)
Sex, men	1129 (53)	1613 (54)	1533 (54)	1655 (54)	1962 (56)	1995 (55)
Patient identifying as Aboriginal and/or Torres Strait Islander	35 (2)	63 (2)	55 (2)	54 (2)	73 (2)	83 (2)
Non-English-speaking background patient requires interpreter	-	282 (9)	284 (10)	243 (8)	204 (6)	231 (6)
Stroke type						
Ischaemic	1671 (79)	2302 (77)	2136 (76)	2391 (78)	2788 (79)	2620 (72)
Intracerebral haemorrhage	340 (16)	512 (17)	519 (18)	532 (17)	656 (19)	605 (17)
Undetermined	108 (5)	171 (6)	166 (6)	158 (5)	70 (2)	426 (12)[1]
FIM on admission[2]						
18-60	462 (31)	698 (31)	767 (33)	983 (33)	1184 (35)	1282 (37)
61-78	318 (22)	480 (21)	493 (21)	583 (20)	696 (20)	744 (21)
79-99	376 (25)	630 (28)	606 (26)	835 (28)	920 (27)	980 (28)
100-126	322 (22)	460 (20)	430 (19)	552 (19)	613 (18)	496 (14)

Q1: 1st quartile; Q3: 3rd quartile; mRS: modified Rankin Scale; FIM: Functional Independence Measure; [1]2018 includes 'Other' stroke types; [2]20-30% missing data in 2008/2010/2012, with <4% missing data in 2014/2016/2018

4.1.2 Impairments

Common impairments on admission are presented in Table 68. Difficulty walking on admission and arm deficit are variables used to account for stroke severity, in addition to the FIM. Overall, more patients were able to walk on admission in 2018 compared to earlier audits.

Table 68 Impairments on admission[1] (2008-2018)

	2008 N=2119 n (%)	2010 N=2985 n (%)	2012 N=2821 n (%)	2014 N=3081 n (%)	2016 N=3514 n (%)	2018 N=3651 n (%)
Difficulties with Activities of Daily Living	1921 (91)	2544 (85)	2444 (87)	2656 (87)	3049 (87)	3168 (87)
Unable to walk on admission	1885 (89)	2257 (76)	2353 (84)	2574 (84)	2617 (75)	2785 (76)
Arm deficit	1490 (72)	2041 (69)	1637 (69)	1821 (69)	2362 (69)	2646 (73)

[1]includes only patients who had assessments recorded (excludes not documented/not assessed/not recorded responses)

4.1.3 Location of inpatient rehabilitation

Although there was variation in the exact question, overall, a greater proportion of patients were treated in a specialist unit (which included a dedicated stroke rehabilitation unit, neurology unit or combined acute/rehabilitation ward) in 2018 compared to earlier audits (Table 69). In hospitals that had a stroke unit (obtained from the organisational survey), variation existed in the proportion of patients who received stroke unit care during their admission. This was potentially related to differences in the definition of a stroke unit across the audits (Table 70).

Table 69 Location of inpatient rehabilitation (2008-2018)

All hospitals	2008 N=2119 n (%)	2010 N=2985 n (%)	2012 N=2821 n (%)	2014 N=3081 n (%)	2016 N=3514 n (%)	2018 N=3651 n (%)
Treated in specialist unit[1,2]	268 (13)[3]	555 (19)	588 (21)	658 (21)	954 (27)[4]	1078 (30)[4]

[1]question varied over years; [2]specialist unit includes dedicated stroke rehabilitation unit, neurological ward or combined acute/rehabilitation unit; [3]only specialist stroke rehabilitation unit vs general rehabilitation unit; [4]combined acute/rehabilitation ward added in 2016/2018

Table 70 Access to stroke rehabilitation units in hospitals with a stroke unit (2008-2018)

Cases from hospitals with a stroke unit[1]	2008 N=293 n (%)	2010 N=485 n (%)	2012 N=345 n (%)	2014 N=246 n (%)	2016 N=243 n (%)	2018 N=432 n (%)
Treated in dedicated stroke unit	240 (82)[2]	211 (44)	323 (94)	230 (94)	204 (84)	352 (81)

[1]reported from organisational survey; [2] includes specialist stroke rehabilitation unit in 2008

4.1.4 Patient assessment

The following section outlines the provision of assessments by the multidisciplinary team by impairment where relevant from 2008 to 2018.

4.1.4.1 Multidisciplinary team assessment

Almost all patients (≥ 99%) accessed physiotherapists and occupational therapists in all audits (Table 71), with the majority also accessing speech pathologists. A greater proportion of patients were seen by a dietitian in 2018 compared to earlier audits (OR 1.07, 95% CI 1.05, 1.08, p<0.001). Similarly, access to psychologists increased between 2008 and 2018 (OR 1.02, 95% CI 1.002, 1.04, p=0.03). However, even in 2018, one in two patients with a mood impairment did not see a psychologist.

Table 71 Multidisciplinary team assessments (2008-2018)

Assessed by[1]	2008[2] N=2119 n (%)	2010 N=2985 n (%)	2012 N=2821 n (%)	2014 N=3081 n (%)	2016 N=3514 n (%)	2018 N=3651 n (%)
Physiotherapist	2092 (100)	2962 (100)	2802 (100)	3032 (100)	3475 (99)	3632 (100)
Occupational therapist	2066 (99)	2940 (99)	2761 (99)	3018 (100)	3482 (99)	3630 (100)
Speech pathologist	1652 (95)	2357 (92)	2370 (94)	2540 (94)	2799 (93)	2966 (95)
Social worker	1577 (88)	2213 (83)	2224 (86)	2313 (83)	2712 (85)	2909 (88)
Dietitian	977 (72)	1400 (65)	1541 (73)	1680 (76)	1881 (74)	2084 (80)
Dietitian, if nutritional complications	-	-	1006 (96)	986 (97)	1034 (94)	1142 (93)
Psychologist	-	395 (17)	363 (17)	388 (17)	526 (21)	657 (26)
Psychologist, if mood impairment	-	217 (34)	185 (41)	191 (39)	280 (37)	414 (48)

[1]excludes those who did not require an assessment, or where patient declined; [2]date of assessment used to determine if assessment occurred in 2008, therefore use caution with interpretation

4.1.4.2 Assessment of impairments

Excluding 2008 where different response options were available, a greater proportion of patients had their mood assessed in 2018 compared to earlier audits (Table 72). However, almost one in two patients did not receive this important process of care in the most recent audit.

Table 72 Assessments of mood and incontinence (2008-2018)

	2008 N=2119 n (%)	2010 N=2985 n (%)	2012 N=2821 n (%)	2014 N=3081 n (%)	2016 N=3514 n (%)	2018 N=3651 n (%)	**2012-2018 Year effect OR (95% CI)**
Mood assessed	1163 (55)[1]	-	967 (34)	1194 (39)	1866 (53)	2057 (56)	1.21 (1.20, 1.24)
Incontinence assessed	-	-	2238 (79)	2543 (83)	2931 (83)[2]	3022 (83)[2]	N/A

OR: odds ratio; CI: confidence interval; N/A: not applicable; [1]variation in response options in 2008 compared to other years; [2]in 2016/2018, the question changed to incontinence assessed 'within 72 hours'

4.1.5 Communication with patients

Variation was evident in the proportion of patients and/or family who met with the team to discuss management across the audits (Table 73). From 2010, an increase in patient-centred goals being set with the patient and family was evident (OR 1.3, 95% CI 1.23, 1.28, p<0.001), with 94% being involved in this process in the 2018 audit. Question changes precluded direct comparisons over the audits for the process related to patients and family receiving information on stroke. When direct comparisons were possible, improvements in this aspect of care were evident from 2016 (50%) to 2018 (62%). However, two in five patients are missing out on this process.

Table 73 Communication with patients (2008-2018)

	2008 N=2119 n (%)	2010 N=2985 n (%)	2012 N=2821 n (%)	2014 N=3081 n (%)	2016 N=3514 n (%)	2018 N=3651 n (%)
Patient/family met with team to discuss management	1843 (87)	2431 (81)	2195 (78)	2695 (87)	2953 (84)	3284 (90)
Goals set with input from patient/family and team	-	2405 (81)	2256 (80)	2686 (87)	3146 (90)	3433 (94)
Patients/family received information regarding stroke[1]	-	1977 (67)	1846 (65)	2219 (72)	1769 (50)	2254 (62)

[1]question different in 2010, different again in 2016/2018 - varying response options

4.1.6 Secondary prevention

Over 89% of patients with ischaemic stroke received antithrombotics on discharge in all audits (Table 74). While provision of lipid lowering medications for those with ischaemic stroke improved from 2008 to 2018, no real change in the prescription of antihypertensives was observed (Figure 28). Although there were changes in questions and response options related to risk factor advice over the audit periods, a steady increase was also noted from 2008 to 2018. In 2018, one in three patients did not receive risk factor advice on discharge.

Table 74 Secondary prevention on discharge (2008-2018)

Patients discharged from hospital	2008 N=2101 n (%)	2010 N=2957 n (%)	2012 N=2789 n (%)	2014 N=3056 n (%)	2016 N=3477 n (%)	2018 N=3613 n (%)
Medications prescribed on discharge[1]						
Antithrombotics (if ischaemic stroke)	1551 (93)[2]	1982 (89)	2018 (97)	2249 (97)	2548 (94)	2407 (94)
Antihypertensives	1599 (78)	2389 (82)	2280 (85)	2413 (82)	2651 (78)	2775 (79)
Lipid lowering treatment (if ischaemic stroke)[3]	1253 (77)	1769 (79)	1751 (84)	1971 (84)	2130 (77)	2100 (85)
Risk factor advice on discharge[3,4]	975 (46)	1170 (42)	906 (34)	1226 (42)	1790 (51)	2178 (60)

[1]excludes those contraindicated to medication; [2]Questions derived from responses to individual medications; [3]response options changed over audits; [4]question changed over audits

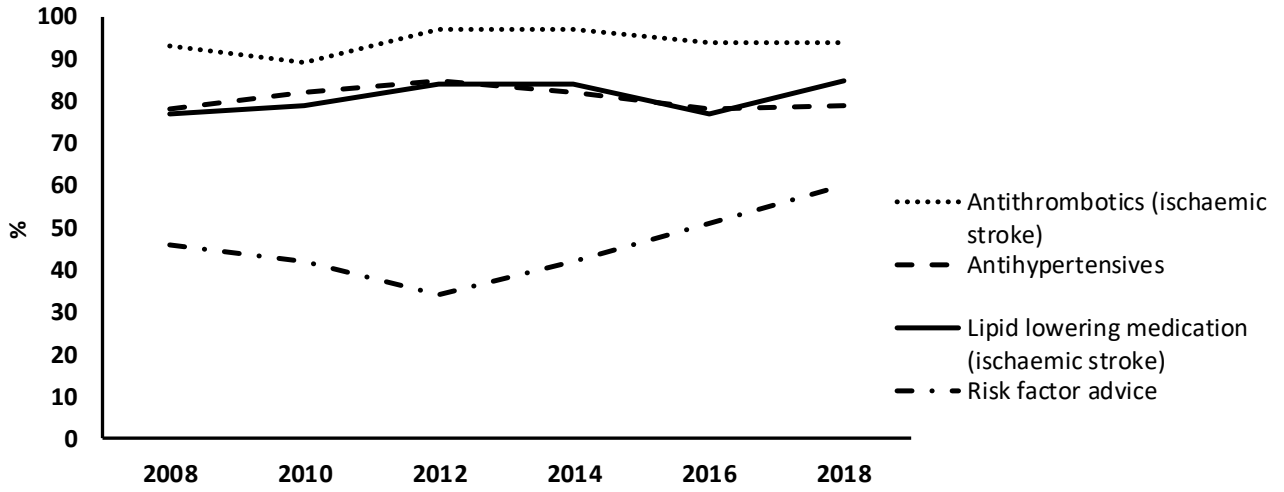


Figure 28 Adherence to secondary prevention processes (2008-2018)

4.1.7 Preparation for discharge

Minimal changes across the audits were seen in the proportion of patients who had a discharge care plan developed with the team, or who were provided with contact details for post discharge questions/programs (Table 75). A discharge summary was provided to the general practitioner for almost all patients who were discharged from rehabilitation in all audits.

Table 75 Preparation for discharge (2008-2018)

Patients discharged from hospital	2008 N=2101 n (%)	2010 N=2957 n (%)	2012 N=2789 n (%)	2014 N=3056 n (%)	2016 N=3477 n (%)	2018 N=3613 n (%)
Discharge care plan developed with team and patient[1,2]	-	1986 (75)	1849 (74)	2307 (84)	2535 (78)	2666 (80)
General practitioner sent discharge summary[2]	1935 (95)	2765 (94)	2609 (94)	2895 (95)	3115 (94)	3178 (95)
Patient or family provided with contact details of someone in the hospital for post discharge questions/programs	1325 (63)	1525 (52)	1577 (57)	1887 (62)	2270 (65)	2410 (67)

[1]if patient had no cognitive issues; [2]different response options over the audits

4.1.8 Life after stroke for patient and family

Across the audits, a greater proportion of patients were provided with information on sexuality or the opportunity to discuss issues related to sexuality (OR 1.19, 95% CI 1.17, 1.21, p<0.001). However, this is an area for improvement, with only 22% having access to this information in 2018 (Table 76). Due to different response options, direct comparisons from 2008 to 2018 for other processes related to life after stroke were not possible. However, from 2016 to 2018 where questions were similar, it was evident that more patients were provided with information about peer support on discharge in 2018 compared to 2016. No real change was seen from 2016 to 2018 in the proportion of patients discharged from hospital who were made aware of self-management programs, or who were assisted to return to driving.

Table 76 Processes related to life after stroke (2008-2018)

Patients discharged from hospital	2008 N=2101 n (%)	2010 N=2957 n (%)	2012 N=2789 n (%)	2014 N=3056 n (%)	2016 N=3477 n (%)	2018 N=3613 n (%)
Discussed or received information related to sexuality	264 (13)	345 (12)	483 (17)	559 (18)	586 (17)	809 (22)
Made aware of generic self-management programs[1]	725 (40)	701 (26)	603 (25)	883 (34)	1410 (41)	1558 (43)
Provided with information about peer support[1]	720 (34)	770 (27)	638 (25)	908 (32)	1226 (35)	1520 (42)
Assisted to return to driving, if wanted to return[1,2]	-	-	572 (98)	622 (97)	679 (89)	708 (92)

[1]different response options over audits; [2]if patient were discharged to usual residence (which changed over audits), includes if the patient was informed of restrictions or provided with information about the process to return to driving or had opportunity to undertake/referred for driving assessment - these options varied over the audits

Different responses and variations in questions limited the direct comparisons for processes related to supporting carers of patients discharged to their usual residence (2016, 2018) or private residence (2014 and earlier). However, from 2016 to 2018 where questions were similar, no change was seen in relation to carer training, assessing the carer's needs, or providing information to the carer on peer support (Table 77).

Table 77 Processes related to supporting the carers in the community (2008-2018)

Patients discharged to usual residence with carer	2008 N=943 n (%)	2010 N=906 n (%)	2012 N=979 n (%)	2014 N=1161 n (%)	2016 N=1059 n (%)	2018 N=955 n (%)
Carer provided with training[1]	566 (67)	589 (71)	727 (78)	912 (84)	798 (75)	700 (73)
Carer's needs assessed[1,2]	812 (88)	759 (86)	753 (78)	932 (82)	686 (65)	600 (63)
Carer received information on peer support[1]	422 (45)	358 (40)	388 (40)	522 (45)	473 (45)	415 (43)

[1]different response options over audits; [2]question changed over the audits

4.1.9 Patient outcomes: Hospital matched analysis

Only 34 hospitals completed all six clinical audits from 2008-2018. For a more robust comparison, the outcomes were reported for hospitals matched on the periods: early (2008 or 2010), mid (2012 or 2014) and late (2016 or 2018). Therefore, to be included in these analyses on the comparison of in-hospital outcomes, the hospital needed to have participated in at least one audit in each of the three periods. A total of 74 hospitals met this requirement.

The following tables show the outcomes that are not adjusted for differences in patient characteristics. The median length of stay for all patients decreased from 25 days in the early period to 22 days in the late period (Table 78).

Table 78 Changes in length of stay in matched hospitals that participated in each period (early, mid, late periods)

Period	Early N=4016	Mid N=4175	Late N=4302
Length of stay days (all) – median (Q1, Q3)	25 (14, 43)	24 (13, 41)	22 (13, 40)

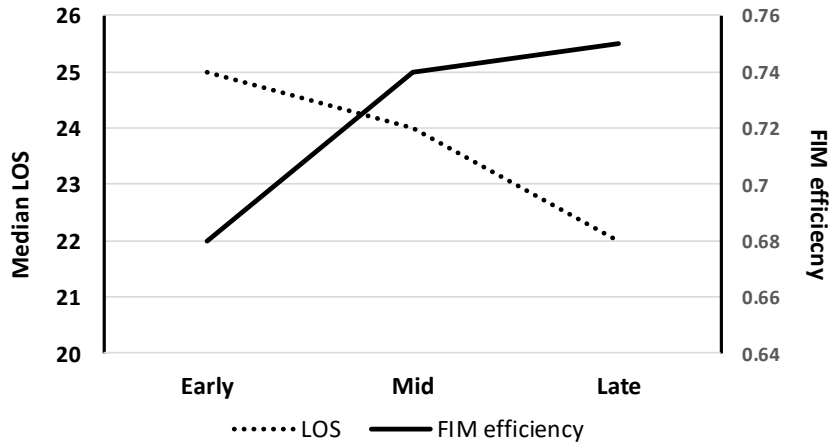
Q1: 1st quartile; Q3: 3rd quartile

Table 79 summarises the in-hospital patient outcomes for matched hospitals that participated in each period (output is not adjusted for patient characteristics). Few deaths occurred in any period (<1%), with similar proportions of patients who died or were dependent on discharge (mRS 3-6). The FIM efficiency improved over the periods, indicating a greater level of improvement (Figure 29). Just under half of the patients were referred for ongoing community or outpatient rehabilitation in the mid and late periods.

Table 79 Unadjusted changes for in-hospital outcomes of matched hospitals (early, mid, late periods)

Hospitals n=74	Early N=4016 n (%)	Mid N=4175 n (%)	Late N=4302 n (%)
Died	36 (1)	38 (1)	36 (1)
Death or Dependency (mRS 3-6)	2492 (65)	2732 (67)	2868 (67)
FIM Range[1]			
18-60	357 (13)	533 (15)	676 (16)
61-78	267 (9)	324 (9)	402 (10)
79-99	539 (19)	647 (18)	760 (18)
100-126	1655 (59)	2157 (59)	2275 (55)
FIM change (median, Q1,Q3)	20 (10, 33)	21 (10, 35)	21 (9, 34)
FIM efficiency[2]	0.68	0.74	0.75
Referred for further outpatient or community rehabilitation[3]	1149 (29)	1876 (45)	1929 (45)

mRS: modified Rankin Scale; Q1: 1st quartile; Q3: 3rd quartile; FIM: Functional Independence Measure; [1]20-30% missing data in 2008/2010/2012, with <5% missing in 2014/2016/2018; [2]FIM efficiency is the mean change in FIM score from beginning to the end of rehabilitation divided by the mean length of stay - the higher the value, the greater level of improvement per day; [3]questions and response options changed for this questions over the audits



LOS: Length of stay; FIM: Functional Independence Measure

Figure 29 Changes in length of stay and FIM efficiency (early, mid, late periods)

No direct comparisons were made for discharge destinations over the periods due to changes in responses over the audits, although a summary is provided in Table 80.

Table 80 Discharge destinations (early, mid, late periods)

Hospitals n=74	Early N=4016 n (%)	Mid N=4175 n (%)	Late N=4302 n (%)
Discharged to usual residence[1]	2640 (66)	2853 (69)	2708 (63)
Discharged to aged care facility[2]	616 (15)	620 (15)	558 (13)
Statistical discharge/episode type change	275 (7)	293 (7)	112 (3)
Other[3]	449 (11)	371 (9)	888 (21)

[1]includes to home alone or with relative +/-support in 2008 to 2014, and in 2016/2018 includes patients returning to existing residential care - care with interpretation required; [2]in 2016/2018 new option is transfer to aged care, however, in prior years, this includes return to aged care if usual residence; [3]includes various options in different audits, e.g. left against medical advice, transitional care services, acute facility, other rehabilitation facility, other, therefore caution is needed with interpretation.

There was still a significant reduction in length of stay evident over the periods after adjusting for patient characteristics known to influence outcomes, including age, gender, stroke type, inability to walk on admission and arm weakness (used as surrogates for stroke severity), geographic location, and patient correlations within the same hospital (Table 81). Although small, a significant improvement in FIM efficiency over the periods was also found.

After accounting for patient characteristics, there was a greater odds of dependency in the late compared to earlier periods.

Table 81 Changes in patient outcomes (2008-2018), adjusted for patient characteristics

	Period effect		
	Coefficient	(95% CI)	p-value
Length of stay days (all) median (Q1, Q3)	-0.62	(-1.1, -0.14)	0.01
FIM efficiency	0.07	(0.05, 0.09)	<0.001
	Period effect		
	OR	(95% CI)	p-value
Died	0.99	(0.77, 1.29)	0.9
Dependency (mRS 3-6)	1.06	(1.01, 1.12)	0.02

All analyses adjusted for age, gender, stroke type, inability to walk on admission, arm deficit, geographic location, adjusted for correlation within hospital; Q1: 1st quartile; Q3: 3rd quartile; CI: Confidence Interval; OR: Odds Ratio; mRS: modified Rankin Scale; FIM: Function Independence Measure

4.2 Clinical Audit: Comparisons by hospital type over early, mid and late time periods

For consistency, hospital type (public/private) comparisons to assess differences in patient characteristics and care provided were performed using the 74 hospitals matched over the three periods: early (2008-2010), mid (2012-2014) and late (2016-2018). Of these 74 hospitals, 68 were public facilities, and 6 were private. Therefore, consideration must be given to the small number of private hospitals that contributed cases in this analysis.

4.2.1 Patient demographics

Overall, there was a greater proportion of patients aged 85 years and above from private hospitals compared to public (Figure 30 & Table 82). Small numbers of patients who identified as Aboriginal or Torres Strait Islander were included from either hospital type. However, there were more non-English speaking patients in public hospitals (Table 82). A greater proportion of 'undetermined' stroke type was found in private hospitals in the late period, specifically driven by coding of 'other' types of stroke. Although there were missing data for the admission FIM, there was a greater proportion of more dependent patients (FIM 18-60) being admitted to public hospitals compared to private facilities.

Table 82 Comparison of patient demographics presenting to public and private hospitals (early, mid, late periods)

	Public N=68 hospitals			Private N=6 hospitals		
	Early N=3835 n (%)	Mid N=3835 n (%)	Late N=4018 n (%)	Early N=181 n (%)	Mid N=340 n (%)	Late N=284 n (%)
Age, years						
<65	985 (26)	904 (24)	943 (23)	14 (8)	26 (8)	21 (7)
65-74	905 (24)	951 (25)	943 (23)	29 (16)	61 (18)	56 (20)
75-84	1296 (34)	1279 (33)	1339 (33)	66 (37)	121 (36)	89 (31)
85+	634 (17)	701 (18)	793 (20)	71 (39)	132 (39)	118 (42)
Sex, men	2037 (53)	2071 (54)	2236 (56)	106 (59)	160 (47)	121 (43)
Patient identifying as Aboriginal and/or Torres Strait Islander	62 (2)	56 (2)	54 (1)	0 (0)	0 (0)	1 (<1)
Non-English-speaking background patient requires interpreter	216 (10)	326 (9)	263 (7)	6 (4)	1 (<1)	2 (1)
Stroke type						
Ischaemic	2990 (78)	2971 (77)	3081 (77)	148 (82)	267 (79)	196 (69)
Intracerebral haemorrhage	635 (17)	678 (18)	738 (18)	22 (12)	56 (16)	38 (13)
Undetermined	210 (5)	186 (5)	199 (5)[1]	11 (6)	17 (5)	50 (18)[1]
FIM on admission[2]						
18-60	902 (33)	1226 (36)	1484 (38)	40 (22)	57 (18)	37 (13)
61-78	574 (21)	701 (21)	832 (21)	34 (19)	49 (15)	47 (17)
79-99	700 (26)	888 (26)	1017 (26)	69 (38)	137 (43)	125 (44)
100-126	540 (20)	594 (17)	558 (14)	38 (21)	75 (24)	75 (26)

Q1: 1st quartile; Q3: 3rd quartile; mRS: modified Rankin Scale; FIM: Functional Independence Measure; [1]2018 includes 'Other' stroke types; [2]20-30% missing data in early and mid periods

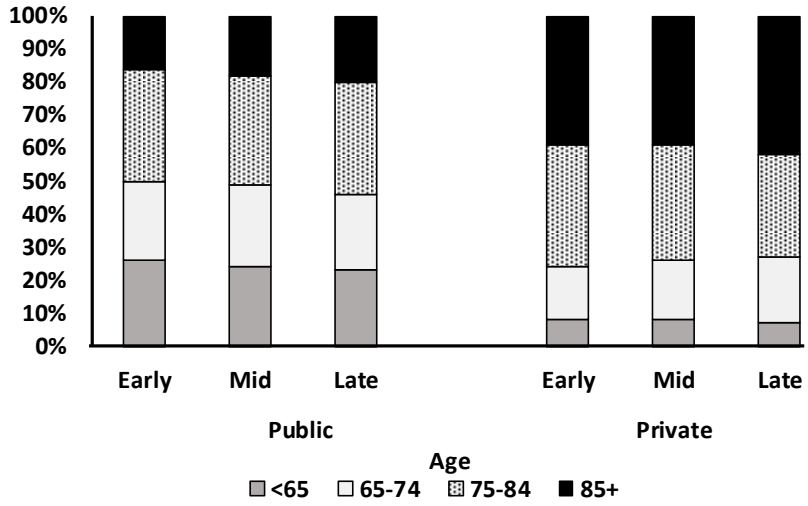


Figure 30 Age distribution by hospital type (early, mid, late periods)

4.2.2 Adherence to key process indicators

Seven key process indicators were identified from recommendations in the 2010 National Stroke Clinical Guidelines.[5] A summary of these indicators is presented below showing change in adherence over the audit periods in public and private hospitals.

For indicators that were able to be compared across audit periods (patient-centred goal setting and mood assessment), improvements were evident in all, irrespective of hospital type (Table 83 & Figure 31). This is with the exception of prescription of antihypertensive medication on discharge which remained at over 80% in all periods for public and private hospitals (Figure 31c). In the late period, care in private hospitals was similar with that in public hospitals for many indicators, including those related to goal setting and risk factor advice. Greater adherence to indicators related to mood assessment ($p<0.001$), care plan development ($p<0.001$), and provision of information related to stroke ($p=0.015$) was seen in private hospitals compared to public hospitals in the late period. The opposite was found for carer training ($p<0.001$), with greater adherence in public hospitals in the late period, and nearly one in three patients with carers missing out on this training if treated in a private hospital.

Table 83 Changes in adherence to the seven key indicators by hospital type (early, mid, late periods)

	Public			Private		
	Early N=3835 n (%)	Mid N=3835 n (%)	Late N=4018 n (%)	Early N=181 n (%)	Mid N=340 n (%)	Late N=284 n (%)
Goals set with input from the team and patient	1724 (80)[1]	3242 (85)	3699 (92)	112 (70)[1]	273 (80)	263 (93)
Patient's mood assessed	-	1494 (39)	2236 (56)	-	116 (34)	192 (68)
Care plan developed with team and patient/family[2,3]	1445 (76)[1]	2669 (78)	2906 (79)	116 (79)[1]	252 (82)	249 (92)
Patient and/or family received information covering stroke[3,4]	1391 (65)[1]	2673 (70)	2190 (55)	111 (70)[1]	264 (78)	176 (62)
Discharged on antihypertensives[5]	3015 (81)	3041 (83)	3093 (80)	154 (86)	275 (86)	236 (86)
Advice on risk factor modification[3,4]	1538 (42)	1397 (39)	2215 (56)	37 (21)	160 (50)	146 (52)
Carers provided with training[3,6]	829 (65)	1031 (82)	841 (76)	18 (62)	103 (80)	48 (57)

[1]question not asked in 2008, therefore based on 2010 data only; [2]if patient had no cognitive issues; [3]difference response options over the audits; [4]exact questions varied over audits; [5]excludes those where medication contraindicated;[6]if patient discharged to usual residence and had a carer

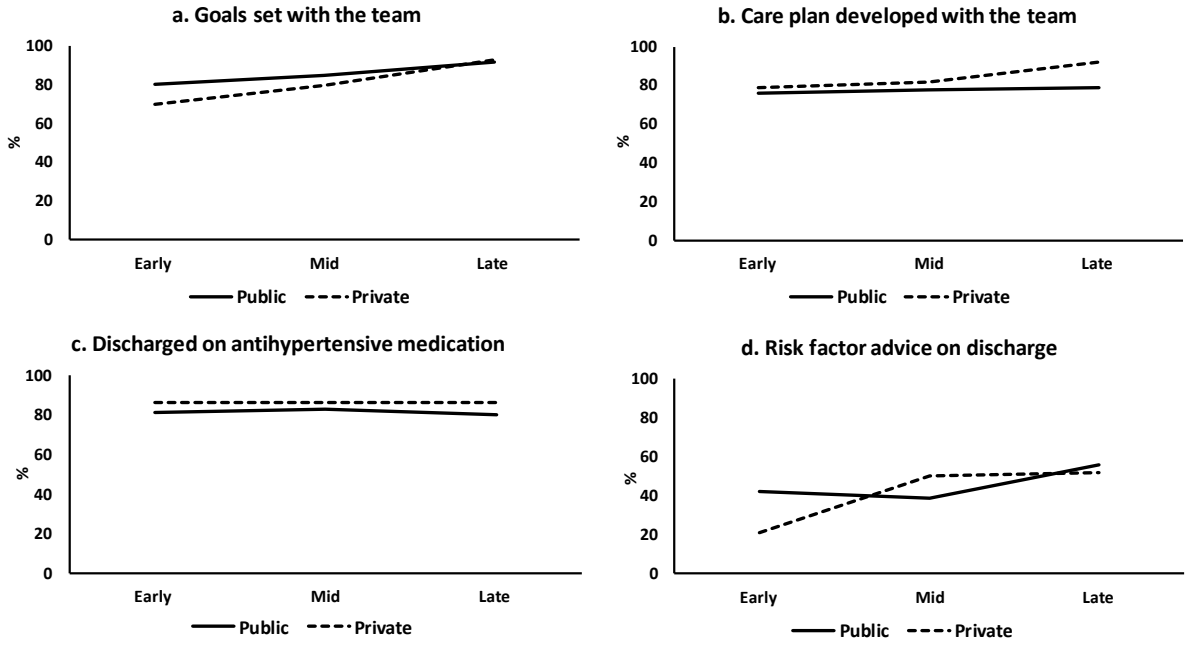


Figure 31 Hospital type comparisons for adherence to key indicators (early, mid, late periods)

4.3 Clinical Audit: Comparisons by annual stroke admission volume over early, mid and late time periods

This analysis included hospitals that participated in each period, however, hospitals could potentially change stroke volume category across periods. Comparisons based on stroke volume breakdown were used to compare adherence to the key rehabilitation indicators over the periods.

A larger proportion of patients were involved in goal setting and received risk factor education in the late period compared to the earlier periods, regardless of hospital volume (Table 84 & Figure 32). Adherence to indicators related to care plan development and prescription of antihypertensive medication on discharge was relatively unchanged over the periods regardless of hospital volume. Just over half of patients/family were provided with information regarding stroke in the late period in the small, medium and large volume hospitals.

Table 84 Changes in adherence to the seven key indicators by hospital volume (early, mid, late periods)

Stroke volume	Small (≤30 admissions)			Medium (31-79 admissions)			Large (80+ admissions)		
	Early N=498 n (%)	Mid N=482 n (%)	Late N=467 n (%)	Early N=2199 n (%)	Mid N=2300 n (%)	Late N=1980 n (%)	Early N=1319 n (%)	Mid N=1393 n (%)	Late N=1855 n (%)
Goals set with input from the team and patient	203 (76)[1]	433 (90)	435 (93)	1197 (87)[1]	1946 (85)	1834 (93)	436 (65)[1]	1136 (82)	1693 (91)
Patient's mood assessed	-	143 (30)	249 (53)	-	882 (38)	1080 (55)	-	585 (42)	1099 (59)
Care plan developed with team and patient/family[2,3]	194 (83)[1]	365 (88)	352 (85)	936 (76)[1]	1596 (78)	1495 (82)	431 (73)[1]	960 (77)	1308 (76)
Patient and/or family received information covering stroke[3,4]	165 (62)[1]	371 (77)	257 (55)	920 (67)[1]	1582 (69)	1104 (56)	417 (62)[1]	984 (71)	1005 (54)
Discharged on antihypertensives[5]	382 (79)	366 (80)	366 (81)	1751 (82)	1835 (84)	1524 (81)	1036 (81)	1115 (84)	1439 (80)
Advice on risk factor modification[3,4]	181 (38)	177 (40)	261 (56)	930 (44)	829 (38)	1017 (52)	464 (36)	551 (42)	1083 (59)
Carers provided with training[3,6]	59 (41)	127 (84)	108 (82)	497 (74)	631 (81)	352 (67)	291 (59)	376 (82)	429 (80)

[1]question not asked in 2008, therefore based on 2010 data only; [2]if patient had no cognitive issues; [3]difference response options over the audits; [4]exact questions varied over audits; [5]excludes those contraindicated; [6]if patient discharged to usual residence and had a carer

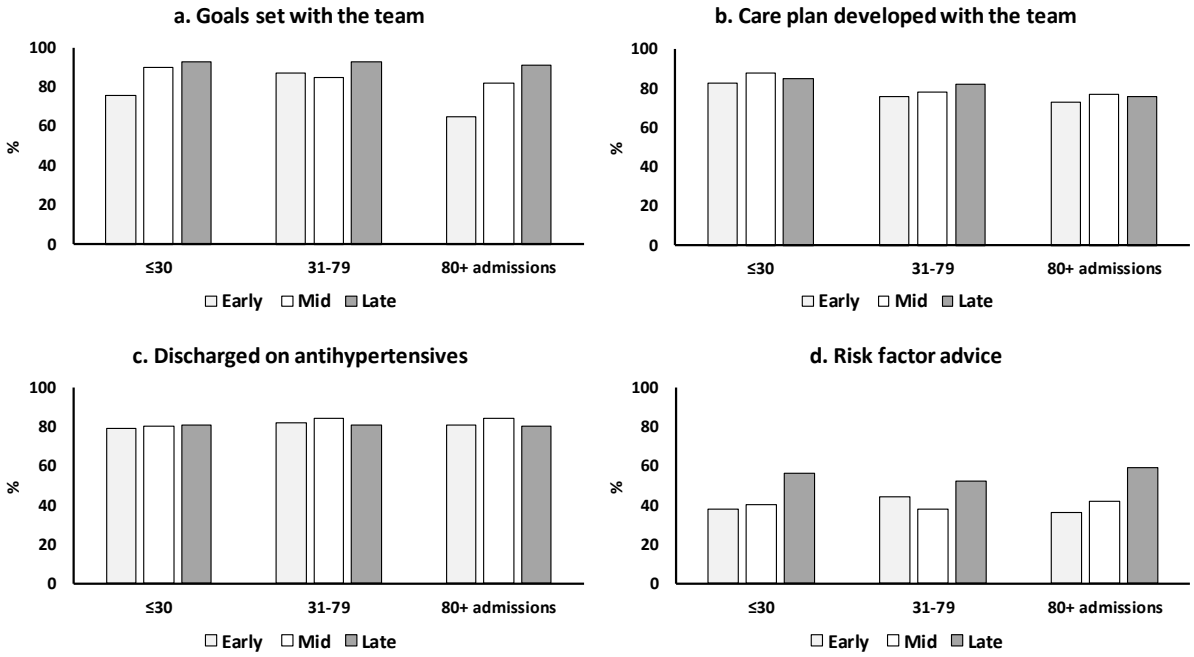


Figure 32 Adherence to key indicators by hospital admissions volume (early, mid, late periods)

5 DISCUSSION

In the rehabilitation audit section of this report, we provide evidence of little change in the quality of care being provided to patients with stroke in rehabilitation hospitals between 2008 and 2018. Data collected in the rehabilitation audit provides a means to monitor and improve the structures and resources for stroke rehabilitation services, and also the care that is being provided to patients with stroke. These data can help guide areas for quality improvement at national, state and local levels. Since 2014, organisational survey data have been mapped to elements of the Rehabilitation Stroke Services Framework,[20] with clinical data reflecting recommendations in national clinical guidelines.[5]

Data from public and private hospitals were included in the rehabilitation report. Approximately 14% of hospitals contributing organisational survey data were private, and 10-13% of the clinical data were provided by private hospitals. Few hospitals participating in the rehabilitation audit were located in rural areas. It is unclear whether this indicates that there are a limited number of stroke rehabilitation services available in these areas, or just that these services chose not to participate in the audit process.

From the organisational survey, it was evident that stroke rehabilitation was most commonly delivered in a general medical rehabilitation ward, frequently within the acute hospital. However, in more recent audits, a higher proportion of hospitals reported prioritising beds for stroke in a specialist unit, which included a dedicated stroke rehabilitation unit, neurological ward or combined acute/rehabilitation unit. The benefits of stroke rehabilitation units have been reported in a previous small meta-analysis.[21] However, variation in the exact definition of a designated stroke rehabilitation unit in previously published work, as well as over the audits, affected our ability to directly compare our findings to these results, but also over the audit periods. Future work is required to determine the features of specialist rehabilitation units and the recommended model of stroke care in rehabilitation hospitals.

Variability in the organisational features of rehabilitation hospitals was seen over the audits. Access to psychology services and staff within hospitals delivering stroke rehabilitation improved from 2008 to 2018. Equitable access still remains problematic, with one in three hospitals not having access to clinical psychology or neuropsychology in the 2018 audit. Since 2008, more hospitals offered programs for continuing education of staff. Nevertheless, gaps in this important element of care remain.

The Rehabilitation Stroke Services Framework comprises 10 recommendations relating to structures, networks, settings and monitoring at rehabilitation services that are considered essential for the improvement of care delivery and patient outcomes. Since 2014, organisational survey data have been mapped to the Framework elements. In 2018, more

hospitals met eight or more of the elements compared to 2014. However, still one in three hospitals were either not resourced, or did not have existing infrastructure to provide the recommended rehabilitation stroke care (evident by meeting less than the half the elements in 2018).

Direct comparisons for many clinical processes over the audits were difficult given the changes in audit questions and response options. For those processes that were comparable, there were minimal changes in many aspects. In some areas, adherence was quite high, such as prescription of antithrombotics for ischaemic stroke (>89% across all audits), and the proportion who had a discharge summary sent to their general practitioner (>94% over all audits), whereby there was little opportunity for further improvement. For other processes relating to preparation of the survivor for discharge and support offered for carers, substantial practice gaps remain, with no improvement over the audits.

As a consequence of a larger proportion of hospitals having access to psychology services, more patients were seen by psychologists in 2018 compared to earlier audits. Nevertheless, one in two patients with a mood impairment did not access these services in 2018. An increase in patient-centred goals being set with the team and patient/family was seen in 2018 compared to earlier audits, and there appeared to be more of a focus on issues related to sexuality. However, 78% still missed out on the opportunity to discuss information related to sexuality in the 2018 audit, highlighting that gaps in important processes involved in stroke rehabilitation still exist. This gap in care provision was also evident in other processes, including information provided to patient/family regarding stroke and risk factor advice on discharge (two in five patients missing out), and three in five did not receive information about self-management programs and peer support to assist with life in the community. There were also minimal improvements to the organisation of stroke care and quality of care in rehabilitation hospitals in both public and private hospitals, and this was consistent across hospital volumes.

Although the audit questions reflect aspects of the Framework and evidence-based recommendations, the body of evidence for stroke rehabilitation is not as robust and clear-cut as in the acute setting. As a result, numerous changes to the questions and response options in both the organisational survey and clinical audit of the rehabilitation audit occurred over the cycles. This resulted in many indicators not being directly comparable, and therefore, unable to be presented in this report. Although the data collected was nationally representative, and a comprehensive data dictionary was used to reduce reporting bias and enhance the reliability of data collection, the cross-sectional nature provides only a snap shot of what is occurring in hospitals providing stroke rehabilitation. The retrospective nature of the audit means data can be influenced by documentation and responder bias. Reliability and logic checks in the web-tool were used to minimise issues with missing clinical data and bias. Reliability checks were performed for the first time on the self-reported organisational data in a select group of hospitals in an effort to validate the responses, and remains an important area moving forward with ongoing audits.

Overall, the results of the rehabilitation audit have been valuable to assess change in care provided in rehabilitation hospitals over 10 years, and highlight areas for ongoing quality improvement. Some improvement in the organisational features around resources, workforce and infrastructure was seen, particularly in relation to elements in the Rehabilitation Stroke Services Framework. Where the data were comparable from the clinical audit, we found that few improvements in stroke rehabilitation had been achieved, and that important gaps in care still exist. Overall, these data have helped to identify where improvements are required, and the need to focus on future quality improvement initiatives, at both national and local levels, in stroke rehabilitation.

Part C:
Economic Impact of Improving Stroke Care Standards

PART C ECONOMIC IMPACT OF IMPROVING STROKE CARE STANDARDS

1 BACKGROUND

The economic burden of stroke is considerable. In 2008-09, total healthcare expenditure for stroke in Australia was approximately $600 million, or 8% of healthcare expenditure for all cardiovascular diseases (which includes cerebrovascular disease).[22] Recently, Kim and colleagues[23] investigated the health benefits and costs associated with improving the standard of care provided to patients who are hospitalised with stroke. Improving the provision of stroke unit care, thrombolysis and secondary prevention medications at discharge (antihypertensive, antiplatelet, anticoagulant and lipid-lowering agents) from national averages to the standard of top-performing 'benchmark' hospitals in 2015 was found to be cost-effective. Using similar simulation methods, we estimated the costs and benefits of changes in practice in the provision of these therapies from the national acute audit program in Australia by comparing: (1) results from 2007 to 2017; and (2) if the national averages were improved to the standard of benchmark hospitals in 2017.

2 METHODS

We adapted a standardised population-based simulation model developed by Kim and Cadilhac[23] to estimate the potential health and economic impact of improving the provision of stroke unit care, thrombolysis and secondary prevention medications at discharge (antihypertensive, antiplatelet, anticoagulant and lipid-lowering agents). We estimated the additional number of patients receiving these treatments if the average standard of care in Australia for these therapies was improved. The health benefits from additional treatment and the costs of the additional therapy were then estimated for a single representative year (2017).

2.1 Number of acute hospitalisations for stroke

The base population cohort was defined as the expected number of acute hospitalisations for stroke in 2017. In the 2017 Stroke Foundation Acute Services Audit, it was reported that there were 31,952 acute stroke admissions among the 127 hospitals audited (6 were private hospitals).[24] These hospitals are likely to be representative of the major Australian hospitals treating stroke. According to the Australian Institute of Health and Welfare (AIHW), there were 62,900 hospitalisations for stroke (based on ICD-10 primary discharge diagnosis codes I60 to I64) of which 36,700 were for the acute care of stroke in 2015-16.[25] As the population of Australia in 2015 was 24.1 million,[26] 0.15% of the population was estimated to suffer a stroke in 2015-16. We then applied 0.15% to the Australian population in 2017 to estimate the number of acute hospitalisations for this analysis (Table 85).

Table 85: Estimated number of acute hospitalisations for stroke

Period	2015-2016	2017	Source
Population of Australia	24.1 million	24.8 million	ABS[26]
Number of acute hospitalisations for stroke	36,700 (0.15%)	37,766[1] (0.15%)	AIHW CVD Snapshot 2016[25]

[1]indicates estimate based on 2015 percentage

2.2 Type of stroke

Some of the evidence-based therapies considered for this analysis were relevant for only certain types of stroke and conditions related to stroke (e.g. anticoagulants for patients with ischaemic stroke and atrial fibrillation). Therefore, we incorporated estimates of the proportion eligible for each therapy. The proportion eligible for each therapy was obtained from the 2017 Stroke Foundation Acute Services Audit,[24] and this was applied to the estimated number of acute hospitalisations for stroke (Table 86). We assumed that 89% of patients experienced a non-fatal stroke and were eligible for secondary prevention interventions (unpublished 2017 Stroke Foundation Acute Services Audit data).

Table 86: Estimated proportion of patients experiencing each type of stroke

Type of stroke	2017 Stroke Foundation Audit	Number of patients in 2017
Number of acute hospitalisations for stroke		37,766
Ischaemic stroke	82%	30,968
With atrial fibrillation	27%	8361
Without atrial fibrillation	63%	22,607
Haemorrhagic stroke	12%	4532
Undetermined	6%	2266

2.3 Potential impact of improvements in the quality of care over time

Table 87 displays the adherence to evidence-based therapies in 2007 and the equivalent proportions in 2017 based on the Stroke Foundation Acute Services Audits. There have been improvements in the quality of care observed between these two time points for the therapies of interest that we modelled.

Table 87: Temporal improvements in the quality of care

Intervention	2007 adherence (95% CI)	2017 adherence (95% CI)
Stroke unit care (all stroke)	51% (49% - 52%)	69% (68% - 71%)
Received thrombolysis (if ischaemic stroke)	3% (2% - 4%)	13% (11% - 14%)
Discharged with antihypertensive medication (all stroke)	76% (73% - 78%)	77% (76% - 79%)
Discharged with antiplatelet medication (ischaemic stroke without AF)	87% (85% - 89%)	90% (88% - 91%)
Discharged with anticoagulant medication (ischaemic stroke with AF)	47% (42% - 52%)	70% (66% - 74%)
Discharged with lipid-lowering medication (ischaemic stroke)	64% (61% - 67%)	86% (84% - 88%)

Source: Stroke Foundation 2017 Acute Services Audit Report and unpublished data; CI: confidence interval; AF: atrial fibrillation

2.4 Simulation of improvements from the national average to the standard of benchmark hospitals in 2017

Table 88 displays current average adherence to evidence-based therapies in the hospitals audited in 2017. These are compared to the adherence at top-performing 'benchmark' hospitals within the same dataset. Benchmarks were calculated using the Achievable Benchmark of Care (ABC™) methodology.[27] Briefly, benchmarks for the provision of a therapy were calculated as the average performance of the top performing hospitals that contributed at least 15% of the total sample of patients eligible for the therapy. The benchmark 'gap' is the difference between the proportion treated in all hospitals (current adherence) and the proportion treated in benchmark hospitals.

Table 88: Adherence to selected processes of care in 2017 Stroke Foundation Acute Services Audit

Intervention	2017 adherence (95% CI)	Benchmark Hospitals
Stroke unit care (all stroke)	69% (68% - 71%)	96%
Received thrombolysis (if ischaemic stroke)	13% (11% - 14%)	20%
Discharged with antihypertensive medication (all stroke)	77% (76% - 79%)	91%
Discharged with antiplatelet medication (ischaemic stroke without AF)	90% (88% - 91%)	93%
Discharged with anticoagulant medication (ischaemic stroke with AF)	70% (66% - 74%)	86%
Discharged with lipid-lowering medication (ischaemic stroke)	86% (84% - 88%)	94%

Source: Stroke Foundation 2017 Acute Services Audit Report and unpublished data; CI: confidence interval; AF: atrial fibrillation

The number of additional patients treated in 2017 compared to 2007 was estimated by applying the temporal improvement observed to the number of patients estimated to be eligible in 2017 (Table 89). The number of additional patients treated if the proportion treated in all hospitals (current adherence) improved to the proportion treated in benchmark hospitals was estimated by applying the benchmark 'gap' to the number of patients estimated to be eligible in 2017.

Table 89: Estimated number of additional patients treated

Intervention	2017 compared to 2007		2017	
	Temporal improvement	Additional patients treated (n)	Benchmark 'gap'	Additional patients treated (n)
Stroke unit care	18%	6798	27%	10,197
Received thrombolysis	10%	3097	7%	2168
Medication provided at discharge				
Antihypertensive	1%	276	14%	3859
Antiplatelet	3%	604	3%	604
Anticoagulant	23%	1712	16%	1191
Lipid lowering	22%	6064	8%	2205

The benchmark 'gap' is the difference between the proportion treated in all hospitals (2017 adherence) and the proportion treated in benchmark hospitals in 2017

2.5 Potential health benefits

In this analysis, we used disability adjusted life years (DALYs) avoided as the common measure of health benefit. A DALY is a year of life lost due to illness, disability or early death.[28] For thrombolysis, we applied a DALY avoided per person treated. For treatment in a stroke unit, we inferred the number of DALYs avoided based on the number of deaths prevented. For the provision of secondary prevention medications, we calculated the number of DALYs avoided based on the number of recurrent strokes prevented. DALYs avoided for each health outcome are provided in Table 90.

Table 90: Disability-adjusted life years avoided per health outcome

	DALY avoided range	Source
Per person treated with thrombolysis within 3 hours	1.28 to 4.4[1]	Hong et al 2010[29]
Per recurrent stroke avoided	3.82 ± 0.14	Hong et al 2010[29]
Per death avoided	8.11 ± 10%	Hong et al 2010[29]

DALY: disability-adjusted life year; [1]4.4 DALYs avoided was used in the base case

We estimated the number of deaths avoided from treatment in a stroke unit and the number of recurrent strokes avoided from secondary prevention by applying the absolute risk reductions of these therapies (Table 91) to the number of additional patients treated if national benchmarks were attained.

Table 91: Intervention effectiveness

Intervention	Control	Outcome	ARR %	Source
Stroke unit care	Alternate ward	Death	6.28	Stroke Unit Trialists Collaboration[17]
Medication provided at discharge				
Antihypertensive	Placebo	Recurrent stroke	1.45	Zonneveld et al.[30]
Antiplatelet	Placebo	Recurrent stroke	1.80	Rothwell et al.[31]
Anticoagulant	Aspirin	Recurrent stroke	5.24	Saxena and Koudstaal[32]
Lipid lowering	Placebo	Recurrent stroke	1.29	Manktelow and Potter[33]

ARR: absolute risk reduction

2.6 Cost estimates

Where costs identified in the literature were not in 2017 Australian terms, these were inflated from their reference year to an equivalent cost in 2015/16 using the total health price index (the 2017 total health price index was not available) unless otherwise stated.[34] A recurrent stroke prevented was valued as a saving of $36,307 (average direct costs to treat a recurrent event for 12 months).[35] Treatment in a stroke unit was assumed to be provided at an additional cost of $2441 per person compared to a general ward.[36] We assumed the cost of administering thrombolysis to be the cost of 70mg of Alteplase ($2937; source: personal communication Boehringer Ingelheim, 2018).

We estimated the benefits of receiving thrombolysis by applying the shift in the modified Rankin Scale (mRS) scores after thrombolysis that were observed by Mishra et al.[37] (Figure 33). Direct costs of stroke according to mRS scores reported by Dewilde and colleagues[38] (Table 92) were applied to the shift in mRS scores (Figure 33). We estimated that thrombolysis could provide a potential opportunity cost (savings) of $6579 per person on average in the year following stroke. The definition of *opportunity cost* or *cost saving* in the context of this report means that resources could be freed up and redirected to another purpose.

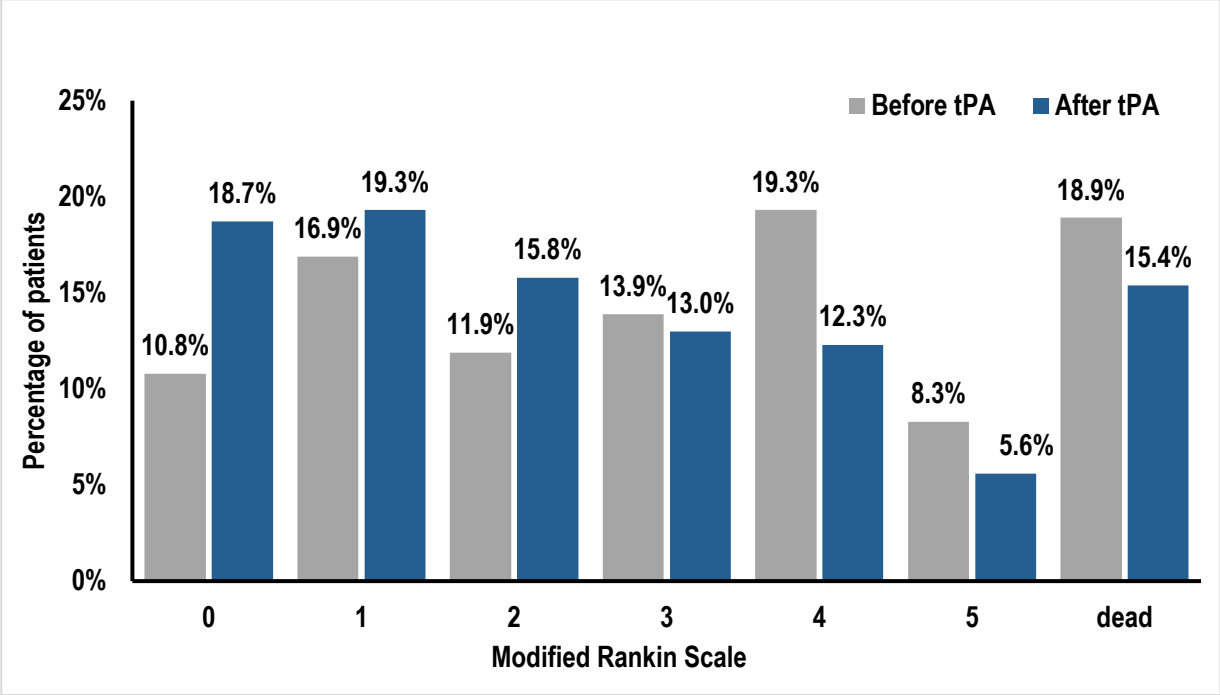


Figure 33: Modified Rankin Scale before and after thrombolysis. Adapted from Mishra et al.[37]

Table 92: Cost estimates for modified Rankin Scale in year after stroke (post-hospitalisation)

mRS	0	1	2	3	4	5
Cost ($[1])	4139.26	8781.95	16,402.50	33,900.16	73,990.08	84,146.88

mRS: modified Rankin scale; [1]The costs displayed in this table were converted from US$ to 2017 Australian dollars using the Purchasing Power Parity conversion rate of $1.472. Source: Dewilde et al.[38]

We estimated a cost of each class of secondary prevention medication (antihypertensive, antiplatelet, anticoagulant and lipid lowering) based on data obtained from the Pharmaceutical Benefits Scheme (http://www.pbs.gov.au/pbs/hom) on the dispensing proportions of the different types of medications within each of the classes and their unit costs. The duration of treatment with secondary prevention was assumed to be one year. Associated costs for the provision of secondary prevention medications were included such as general practitioner visits, blood tests and other diagnostic tests (e.g. electrocardiograms). We sourced these associated costs from the Medicare Benefits Schedule (http://www.mbsonline.gov.au/internet/mbsonline/publishing.nsf/Content/Home). The total estimated costs of providing secondary prevention medication per year is provided in Table 93.

Table 93: Cost of providing secondary prevention medication for 12 months

Secondary prevention medication	Cost per patient ($)
Antihypertensive	256
Antiplatelet	270
Anticoagulant	851
Lipid lowering	361

2.7 Sensitivity analysis

Probabilistic, multivariable sensitivity analysis was conducted to vary all model inputs simultaneously in 10,000 (Monte Carlo) simulations using @RISK (Palisade Corporation; Ithaca, NY). The proportion of patients receiving therapy in 2007 and 2017 (Table 87) was varied by the 95% confidence intervals in uniform probability distributions. The number of patients eligible for therapy (Table 86), benchmark performance (Table 88), absolute risk reductions from treatment in a stroke unit and the provision of secondary prevention medication (Table 91), and cost estimates (Table 92 and Table 93) were pragmatically varied by up to ±10% of their base value in uniform probability distributions. Estimates of DALYs avoided were also varied as per the ranges listed in Table 90.

3 RESULTS

Improving the selected standards of acute stroke care in Australia from the averages observed in 2007 to the averages observed in 2017 resulted in an estimated additional 6798 patients being treated in a stroke unit and 3097 patients being provided with thrombolysis (Table 94). Improving the provision of stroke unit care was estimated to have prevent 427 deaths and avoid 3462 DALYs. These estimated benefits would potentially be achieved for an additional $16.6 million in healthcare expenditure. Improving the provision of thrombolysis from current adherence to benchmark adherence levels was estimated to avoid 13,626 DALYs and provide potential opportunity cost offsets (savings) of approximately $11 million in costs.

Secondary prevention medications provided at discharge were potentially cost-saving. Lipid-lowering medications had the least benefit due to their lower efficacy in preventing recurrent events. Improving the prescription of all secondary prevention medications from the standard of care provided in 2007 to the standard of care in 2017 was estimated to prevent 183 additional strokes, avoid 698 DALYs and provide opportunity cost offsets (savings) of approximately $2.8 million.

Table 94: Potential impacts of the improvement in the standard of care between 2007 and 2017

Secondary prevention provided at discharge	Additional patients treated	Strokes prevented	Cost impact ($)	DALYs avoided
Antihypertensive	276	4	-74,677	15
Antiplatelet	604	11	-231,495	42
Anticoagulant	1712	90	-1,800,397	343
Lipid lowering	6064	78	-650,483	299
Sub-total (i)		**183**	**-2,757,052**	**698**
Other acute care	Additional patients treated	Deaths prevented	Cost impact ($)	DALYs avoided
Stroke unit care	6798	427	16,596,276	3462
Intravenous Thrombolysis	3097	-	-11,278,301	13,626
Sub-total (ii)		**427**	**5,317,976**	**17,088**
Grand Total (i + ii)		**-**	**2,560,924**	**17,786**

DALY: disability-adjusted life year. Negative cost impact indicates a cost saving.

In total, 17,786 DALYs were estimated to have been avoided at an additional cost of $2.5 million, equating to a cost per DALY avoided of $144. In 95% of the simulations in the sensitivity analysis, the additional treatment cost between $8358 per DALY avoided and the additional treatment being 'dominant' over the standard of care provided in 2007 (i.e. more effective and cost saving). In 44.5% of the simulations, the additional care provided in 2017 was found to be dominant over the standard of care provided in 2007 for the therapies we assessed (Figure 34). It was estimated that between 101 and 303 recurrent strokes would be prevented and between 324 and 616 deaths would be prevented with the additional treatment.

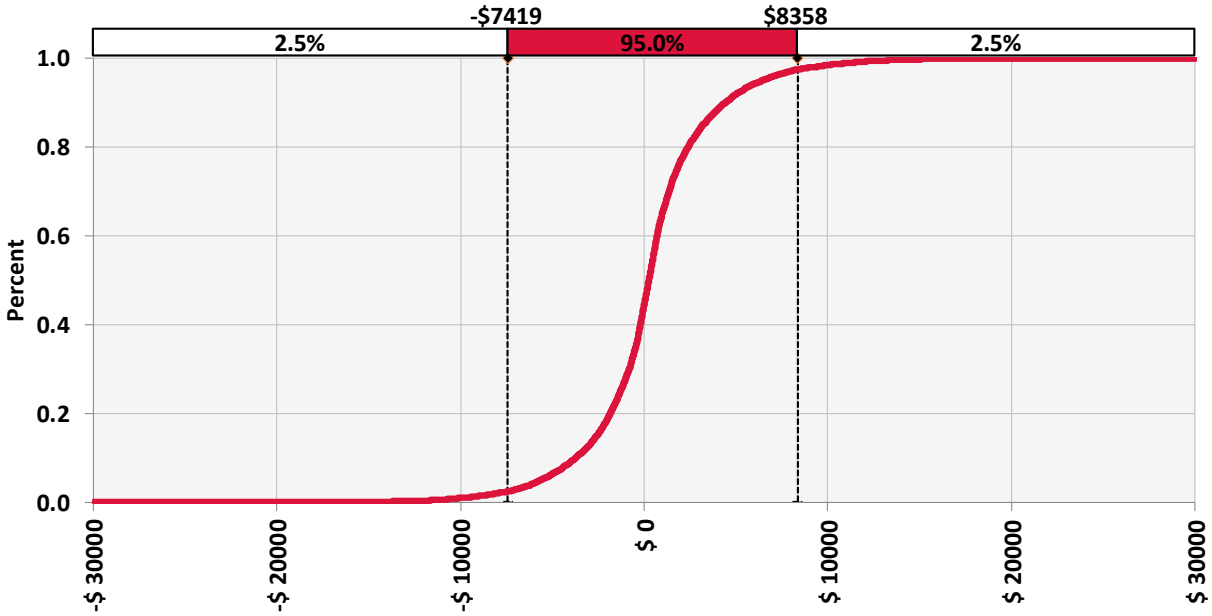


Figure 34: Cost-effectiveness acceptability curves of providing additional treatment (treatment at 2017 standard compared to 2007). The probabilities of achieving cost-effectiveness (y axis) are plotted against the cost per disability adjusted life year avoided (x axis).

Improving the average standard of care in 2017 to that of benchmarks for the six quality indicators included in this analysis was found to avoid 15,334 DALYs at an additional cost of $14,223,643 or $928 per DALY avoided (Table 95). In sensitivity analysis, the 95% uncertainty interval went from $7502 per DALY avoided with quality improvement to the standard of 2017 benchmark hospitals, to this quality improvement being 'dominant' over the actual standard of care in 2017. In 30.8% of the simulations, improving the standards of acute stroke care to the standard of 2017 benchmark hospitals was found to be dominant over actual standards of care in 2017 (Figure 35). It was estimated that between 30 and 298 recurrent strokes would be prevented and between 321 and 873 deaths would be prevented with the additional treatment.

Table 95: Costs and benefits of improving the average standard of acute stroke care to 2017 benchmark standards

Secondary prevention provided at discharge	Additional patients treated	Strokes prevented	Cost impact ($)	DALYs avoided
Antihypertensive	3859	56	-1,045,476	214
Antiplatelet	604	11	-231,495	42
Anticoagulant	1197	62	-1,252,450	238
Lipid lowering	2205	28	-236,539	109
Sub-total (i)		158	-2,765,961	602
Other acute care	Additional patients treated	Deaths prevented	Cost impact ($)	DALYs avoided
Stroke unit care	10,197	640	24,894,414	5193
Intravenous Thrombolysis	2168	-	-7,894,810	9538
Sub-total (ii)		640	16,999,604	14,731
Grand Total (i + ii)		-	14,223,643	15,334

DALY: disability-adjusted life year. Negative cost impact indicates a cost saving.

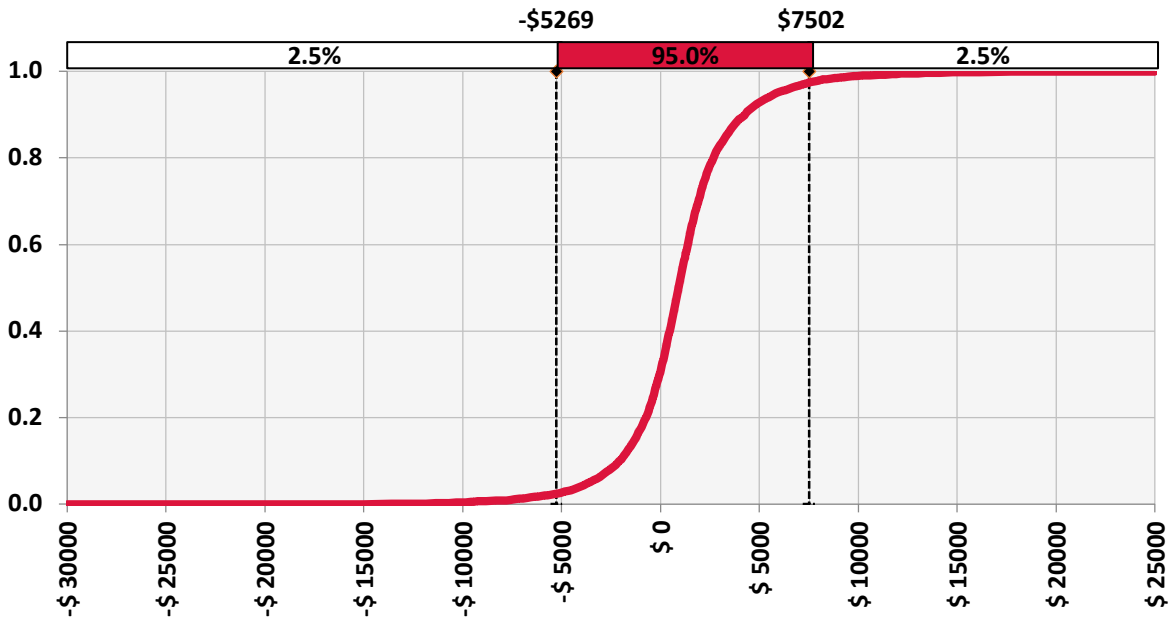


Figure 35: Cost-effectiveness acceptability curves of providing additional treatment (treatment at 2017 benchmark standard compared to 2017 average). The probabilities of achieving cost-effectiveness (y-axis) are plotted against the cost per disability adjusted life year avoided (x-axis).

4 SUMMARY

Considerable improvements in the quality of care were observed over time. The number of additional patients who would receive treatment in 2017 in comparison to 2007 and the costs and benefits of this additional treatment were estimated. It was estimated that without this additional treatment, over 17,000 healthy years of life would be lost in 2017 (17,786 DALYs). The additional resources required to provide this additional treatment were relatively inexpensive. After considering the savings to the health system due to better health, it was estimated that to gain this benefit it would cost an additional $2.5 million, or $144 per DALY avoided. This would be considered good value for money since the usual willingness-to-pay threshold for an additional year of healthy life is generally accepted as the national annual gross domestic product per capita (approximately $50,000 in Australia).[39]

We also identified benchmark hospitals that provided the best standard of care in Australia. We then estimated the costs and benefits of improving the standard of acute stroke care to the standard of these benchmark hospitals Australia-wide. It was estimated that by not providing treatment at the standard of these benchmark hospitals, over 15,000 healthy years of life were being lost in 2017 (15,334 DALYs). The estimated costs of the additional treatment required to prevent this loss of healthy years of life was an estimated $14.2 million or an additional $928 per DALY avoided. Again, this was still relatively good value-for-money since we are willing to pay up to $50,000 per DALY avoided in Australia.[39]

The data collected by the Stroke Foundation for the Audit of Acute Services is important to detect improvements in the quality of care over time and identify any variability between hospitals in the quality of care provided. In this analysis, we used the data collected by the Stroke Foundation to estimate the costs and benefits of improving the delivery of six major therapies for patients with stroke. There was evidence of improvement in provision of other evidence-based therapies between 2007 and 2017 and new evidence-based therapies have become standard practice during this time. While the estimated health benefits would be greater if these therapies were included in the model, the costs associated with providing these therapies is uncertain.

The improvements in the quality of care observed between 2007 and 2017 in Australia can be attributed to several programs that have aimed to improve the acute care of patients with stroke, including the audit and feedback funded by the Stroke Foundation. The Stroke Foundation also uses the data collected to promote quality improvement by providing reports to staff at participating hospitals that compare the provision of acute care at their hospital with similar hospitals. It is estimated that audit and feedback programs can improve the proportion of patients provided evidence-based therapies by between 0.5% and 16%, with the greatest improvements where the quality of care is poor.[40]

The estimated benefits to the health of the Australian community from improving the quality of care provided to patients with stroke were substantial. There is evidence to support further investment in initiatives that will drive quality improvement in Australian hospitals that treat patients with acute stroke. Data collection programs, such as that conducted by the Stroke Foundation, are essential for identifying opportunities to improve the standard of care provided by hospitals treating stroke.

Part D:
Changes in Data Monitoring, Policy and Practice for Stroke Care

PART D CHANGES IN DATA MONITORING, POLICY AND PRACTICE FOR STROKE CARE

OVERVIEW

As outlined in the previous sections, the Acute and Rehabilitation Stroke Services Audit Program has been undertaken since 2007 to assess the quality of care and outcomes for patients with stroke in Australia. The data from these audits have been used to inform a number of clinical and policy initiatives in addition to contributing to the broader evidence landscape via conference presentations and peer-reviewed journal articles. This part of the report includes different sections covering complementary activities to improve the quality of care in hospitals, as well as data collection methods used to measure the impact of these activities. In addition, a description of changes or progress over the last 10 year period is presented, along with future considerations for data monitoring. The following provides an outline of these sections:

- **Contextual evidence base for policy and practice**
- **Progress with data monitoring and the use of the data**
- **Quality improvement activities in hospitals**
- **Publications using audit data to influence policy and practice for monitoring and improving stroke care and patient outcomes**
- **Future directions**

A pictorial overview of the time horizon for establishing evidence-based recommendations, data monitoring programs and quality improvement initiatives undertaken in Australia is depicted in Figure 36. These recommendations, programs and initiatives will be further expanded on in this part of the report to provide context for the understanding of the impact of the audit program in Australia.

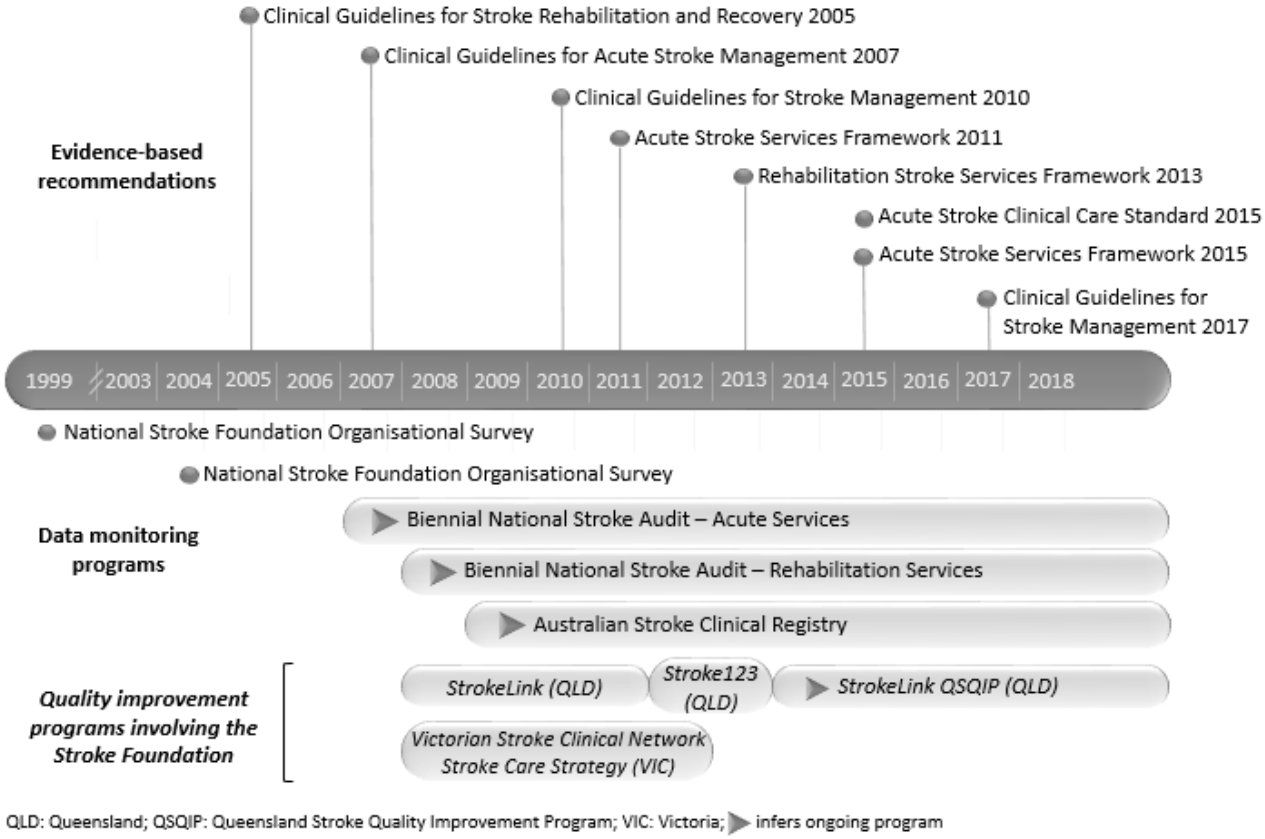


Figure 36 Summary of evidence-based recommendations, data monitoring initiatives and quality improvement programs (1999-2018)

1 Contextual evidence base for policy and practice

- **National Stroke Clinical Guidelines**
- **Stroke Clinical Care Standard**
- **Acute and Rehabilitation Frameworks for stroke**

The indicators collected within both the acute and rehabilitation audits are based on the most rigorous and up to date evidence base, which is drawn from a variety of recommendations outlined in the following section.

Clinical guidelines for stroke are based on the latest research and provide the recommendations for best practice care for stroke and transient ischaemic attack, with endorsement by the National Health and Medical Research Council. Initially, separate guidelines for acute (Clinical Guidelines for Acute Stroke Management 2007[41]) and rehabilitation (Clinical Guidelines for Stroke Rehabilitation and Recovery 2005[19]) stroke care were published by the Stroke Foundation. These two documents were updated and amalgamated in the Clinical Guidelines for Stroke Management 2010[5] which covered recommendations across the whole continuum of stroke care, from pre-hospital to community participation and long-term care. More recently the Clinical Guidelines for Stroke Management 2017[14] were released by the Stroke Foundation, which supersede the previous document. The current objective is to have the latest release provided as a 'living guideline', incorporating a system where the most recent research and evidence can be used to rapidly update guideline recommendations (https://informme.org.au/Guidelines/Living-guidelines-for-stroke-management). Adherence to guideline recommendations is assessed in both the acute and rehabilitation clinical audits.

The Acute Stroke Clinical Care Standard[12] was developed by the Australian Commission on Safety and Quality in Health Care, in collaboration with consumers, health organisations, clinicians and researchers. The standard summarises a small number of quality statements that outline acute care that patients should be offered based on current evidence. Each quality statement offers information on what patients can expect, provides guidance to health professionals in delivering the care, and sets out components for health services to guide, monitor and improve performance in the standards. A set of indicators reflecting the quality statements was developed. Performance against these clinical standard indicators was reported in the 2015 and 2017 National Report. These standard indicators can be a tool for quality improvement to assist teams and health services at a local level to monitor performance against the priority areas of the Clinical Care Standard.

Rather than recommendations based more specifically on the clinical care that patients with stroke should receive, the current Acute Stroke Services Framework[6] and National Rehabilitation Stroke Services Framework[20] provide an outline of what is required to support delivery of best practice care based on major aspects of the clinical guidelines and the standard. The Framework includes elements such as structures, networks, settings, workforce and criteria for monitoring care. Having the capacity to plan, deliver and evaluate implementation of these organisational elements for acute and rehabilitation stroke services is essential for prioritising improvements in care delivery and patient outcomes. The Stroke Foundation developed the initial Framework for the acute sector, with funding support from the Australian Government in 2002. This was then updated in 2008, prior to publication of the Acute Stroke Services Framework 2011 and the more recent Acute Stroke Services Framework 2015. In 2013, a Rehabilitation Stroke Services Framework was published. To date, organisational data collected from the 2011, 2013, 2015 and 2017 Acute Audits have been evaluated against the key elements described in the Acute Framework. Similarly, 2014, 2016 and 2018 organisational data have been mapped to the elements in the Rehabilitation Framework to help determine uptake of these recommendations into practice in Australian hospitals delivering acute care and rehabilitation to patients with stroke.

Throughout the audit program, ongoing review and iteration of the audit questions and responses ensure the data collected reflect the most current evidence base. This ensures that certain data collected are able to be reliably used for assessing current clinical care and service provision recommendations most likely to improve outcomes of patients with stroke.

2 Progress with data monitoring and the use of the data

In this part of the report, the following topics are addressed:

- **Acute Audit reports: 2007, 2009, 2011, 2013, 2015 and 2017**
- **Rehabilitation Audit reports: 2008, 2010, 2012, 2014, 2016 and 2018**
- **Complementary national data collection program**
- **Strengths and limitations**

Monitoring the quality of care provided in Australian hospitals is a focus of importance for clinicians and providers of care, as well as for funders and consumers. By measuring adherence to indicators based on clinical guidelines, standards and frameworks, the national audit program provides a system to monitor and improve the clinical care of patients with stroke in Australia. This is particularly important considering high-level adherence to important indicators has been shown to reduce in-hospital mortality and improve outcomes of patients with stroke.[16, 42] To date, detailed information from over 21,599 patients treated in acute hospitals and 18,171 in rehabilitation hospitals has been audited via the Stroke Foundation Audit Program.

Since the inception, data from the Stroke Foundation Audit Program have been used to:

- measure the quality of care for stroke and its immediate consequences for patients admitted to acute and rehabilitation hospitals with stroke;
- contribute to a greater understanding of the availability of services for stroke in hospitals including resources;
- provide evidence for different models of stroke care;
- provide evidence for reporting on the quality and cost-effectiveness of care;
- assist the development of a framework for stroke research and service development in Australia;
- provide data for secondary purposes; including the evaluation of quality improvement initiatives (part 3 of this section), the investigation of important research questions (highlighted in part 4 of this section), and for analyses by other external groups and higher degree students.

As reflected in Part A, there have been significant changes in the organisation of stroke care from 1999 to 2017, particularly in relation to access to stroke unit care, with the proportion of stroke units increasing from 26% in 1999 to 79% in 2017. While thrombolysis was recommended in 2007 clinical guidelines, the provision of thrombolysis has become more nuanced as the evidence base for eligibility and benefit has grown. In 2017, 77% of hospitals offered this service compared to 37% in 2007. Tweaks to the health system to facilitate faster provision of reperfusion continue to be made such as telemedicine, and use of hospital bypass. Other aspects of acute care delivery have also improved over the 10-year period in line with clinical guideline recommendations, including access to timely allied health, involvement of the patient and family in management decisions, education around risk factor advice, and support for patients and carers returning to the community.

While the improvements to the provision of acute care have been dynamic, few changes to care in stroke rehabilitation have been observed. This potentially has been influenced by the limited and quite diverse evidence-base available for directing care, and the complex nature of rehabilitation. However, as seen throughout Part B, improvements relating to important service elements outlined in the National Rehabilitation Stroke Services Framework were seen from 2014 to 2018.

In addition to the National Audit Program, prospective data collection via the AuSCR began in 2009, as a means to provide ongoing measurement of the quality of care and outcomes for consecutive patients with acute stroke.[18] The focus of AuSCR is to collect a small number of core data variables with the view that this information can be obtained for the vast majority of admitted patients with stroke. When data collection needs to be continuous, it is preferable that the number of data variables are minimised. Conversely, the audit program can be used to collect a snapshot of data on a much larger range of variables. Both these programs have been operating within a single integrated data collection system since 2016, via the AuSDAT, which has provided the opportunity to harmonise the data collection process. A great benefit has been the ability to simplify the data and minimise the burden of data collection for clinicians.

There are a number of strengths and limitations relating to monitoring of data for the audit program. Strengths of the audit program involve the large comprehensive data sets which include a considerable number of variables, reflective of evidence-based recommendations from clinical guidelines, the national standard and frameworks across the continuum

of care for stroke. National representation was also obtained, with hospitals in all states and territories participating. Use of a comprehensive national data dictionary also reduced the risks of reporting bias and enhanced the reliability of data collection.

The cross-sectional samples collected provide only a snapshot of care, and it cannot be assumed that the audit data are representative of all patients with stroke. The retrospective nature of the clinical audit relies on the accuracy of medical record data, which can vary in accuracy and completeness. Encouragingly, the amount of missing data for many variables has decreased in recent audits with the use of mandatory responses for many questions built into the AuSDAT. The influence of responder bias was monitored by the reliability checks, where numerous cases were entered by two auditors. With all organisational data being self-reported, a means to validate these responses would be beneficial. Investigation of potential differences in the rate of improvement of both organisational and clinical care over audits based on hospital type, geographical location or admissions was beyond the scope of this report, but would be beneficial in future publications to further inform policy and practice.

Every effort was made to ensure only comparable variables were included in this report. With the introduction of the AuSDAT, it is anticipated that minimal changes will be made moving forward, and a greater number of reliable comparisons to assess changes in care provision can be made in the future. Each acute and rehabilitation audit is performed biennially, and so provides a broad overview of changes that have occurred across audit periods. In order for hospitals to be more responsive to quality improvement processes and individual hospitals' needs, there is the potential to use data collected from the AuSCR. This would provide continuous prospective data collection, including information on longer-term outcomes such as quality of life and mortality. Using the AuSCR may also provide greater flexibility to use the AuSDAT for spot audits on specific aspects of care.

3 Quality improvement activities in hospitals

- **Audit and feedback cycle**
- **Benchmarking**
- **Quality improvement programs**

A central element of the National Audit Program is the 'audit and feedback' loop (Figure 37). It is estimated that programs incorporating audit with feedback can improve the proportion of patients provided with evidence-based therapies from 0.5% to 16%.[40] Not only is a national report outlining countrywide and state-based adherence to the indicators published after each audit cycle, individual performance reports are provided to stakeholders at hospitals and state government e.g. via their Stroke Clinical Networks. In these reports, local results are measured against peer hospitals and national adherence to encourage quality improvement activities by hospital staff. The ability to benchmark both individual hospital level, and national level performance data to an achievable standard of excellence over time provides a valuable means to promote improvements in the quality of care provided. By improving the standard of stroke care in Australia to achievable benchmarks, there is the potential to provide substantial gains in healthy life outcomes, with small additional costs.[23] Therefore, the ability to monitor and encourage improvements in care provision over time is important.

Figure 37 Summary of Audit and Feedback Loop

In Australia, stroke-related quality improvement activities occur at local, state and national levels. These initiatives are driven by various factors, including priorities of state governments and their relevant Stroke Clinical Networks, and associated policies or project initiatives. These activities occur at different time points in response to various levels of investments and funding, activity and involvement of state governments, and health care priorities.

As an example, in 2007, the State Government of Victoria developed the Stroke Care Strategy (Strategy) for Victoria. The Strategy provided a framework outlining a means to prioritise and reduce evidence practice gaps in acute and subacute stroke care.[43] A pre-post evaluation was undertaken using acute audit data from 2007/2009, and 2011. Improvements in access to stroke unit care, and thrombolysis rates, were seen, with increased adherence to the relevant priority areas in the period after the intervention.[44] The associated cost analysis showed that implementation of the initiatives related to the Strategy potentially offered important cost saving returns on investments.[45]

Another example is StrokeLink, a quality improvement program coordinated by the Stroke Foundation in collaboration with the Queensland State-wide Stroke Clinical Network. The program began in 2008/2009, with the aim to facilitate quality improvement in stroke care within Queensland hospitals (Figure 36). The program included workshops, outreach visits and support by trained staff to assist local clinicians interpret and act on feedback from acute audit data provided. The StrokeLink program was refined and developed in the subsequent years with a new partnership project funded by the NHMRC (Stroke123),[46] and incentive funding for stroke unit access provided by Queensland Health. Acute audit data and data from the AuSCR, which included longer-term patient outcomes, were fed back. The most recent modification involved the development of the Queensland Stroke Quality Improvement Program (QSQIP), which was based on developing a theory-informed implementation intervention.[47] Throughout all the changes, the important constant was the use of audit and feedback using benchmarked clinical data.

There is evidence from the national audit that there have been steady improvements in adherence to both Framework recommendations and nationally approved clinical indicators for acute stroke management from 2007 to 2017. This is in response to passive audit and feedback coupled with active local, state and national quality improvement activities. However, in the rehabilitation setting there was little to no improvement in adherence to nationally approved clinical indicators between 2008 and 2018, despite some improvements related to recommended infrastructure and service provision being evident. Limited quality improvement activities have been undertaken in stroke rehabilitation in Queensland hospitals, with no national level initiatives in this setting during this period. In the future, broader quality improvement activities may be required for hospitals treating patients with stroke in the rehabilitation setting.

4 Publications using audit data to influence policy and practice for monitoring and improving stroke care and outcomes

As outlined in this part of the report, the Stroke Foundation have led the acute and rehabilitation audits undertaken in Australian hospitals since 2007 (acute) and 2008 (rehabilitation). Subsequent secondary analyses of these data to explore specific research questions have been presented over 30 times at conferences by various contributors to the audit program, the Stroke Foundation and Monash research team (see Appendix for list of published abstracts), and in a number of peer reviewed journal articles (Table 96). These figures likely underestimate the translation of this work to the broader audience given the Stroke Foundation have done presentations of these data in different fora. Below we outline a synopsis of the articles that have been produced using data from the audit program.

Table 96 Summary of publications

Title of articles and journal
National Stroke Audit: The Australian experience (Harris et. al., *Clinical Audit*, 2010)[48]
Identification of a reliable subset of process indicators for clinical audit in stroke care: an example from Australia (Cadilhac et al., *Clinical Audit*, 2010)[49]
Adherence to Clinical Guidelines Improves Patient Outcomes in Australian Audit of Stroke Rehabilitation Practice (Hubbard et al., *Archives of Physical Medicine and Rehabilitation*, 2012)[50]
Hospital management and outcomes of stroke in Indigenous Australians: evidence from the 2009 Acute Care National Stroke Audit (Kilkenny et. al., *International Journal of Stroke*, 2013)[51]
Outcomes for people with atrial fibrillation in an Australian national audit of stroke care (Andrew et. al., *International Journal of Stroke*, 2014)[52]
Improved in-hospital outcomes and care for patients in stroke research (Purvis et. al., *Neurology,* 2016, & letter of correspondence, *Nature Reviews Neurology*, 2017)[53, 54]
Hospitals admitting at least 100 patients with stroke a year should have a stroke unit: a case study from Australia (Cadilhac et al., *BMC Health Services Research*, 2017)[55]
The potential health and economic impact of improving stroke care standards for Australia (Kim et. al., *International Journal of Stroke*, 2017)[23]
Benefits of clinical facilitators on improving stroke care in acute hospitals: a new programme for Australia (Purvis et. al., *Internal Medicine Journal*, 2017)[44]
Is length of time in a stroke unit associated with better outcomes for patients with stroke in Australia? An observational study (Busingye et al., *BMJ Open*, 2018)[56]
Influence of stroke coordinators on delivery of acute stroke care and hospital outcomes: An observational study (Purvis et al., *International Journal of Stroke*, 2018)[57]
Care bundle for fever, hyperglycaemia, and swallow management for patients with acute stroke: evidence of upscale and spread (Purvis et al., Under Review)
Sustaining best practice in stroke beyond the funded programme period: adherence to evidence-based care (Francis et al., Under Review)

A review of the published papers to date is presented below.

National Stroke Audit: The Australian experience[48]

The first national stroke Acute Audit was undertaken in 2007 to measure compliance with stroke clinical guidelines. This audit was established to monitor the quality of clinical practices in acute stroke management. Hospitals treating patients with stroke conducted a retrospective clinical audit of up to 40 cases admitted between October 1, 2006 and March 31, 2007. Eighty-nine hospitals contributed clinical audit data on 2724 people with acute stroke. There were clear discrepancies between clinical guideline recommendations and clinical practice. Only half the patients audited were treated in a stroke unit. Few patients with ischemic stroke (3%) received thrombolysis. Secondary prevention on discharge was inadequate: a quarter did not receive antihypertensives, a third did not receive lipid-lowering medication, and two-thirds did not receive lifestyle advice. Adherence to discharge planning processes was poor (11%–53%). The audit provided insights into the performance of the Australian health system on providing acute stroke care.

Identification of a reliable subset of process indicators for clinical audit in stroke care: an example from Australia[49]

With the completion of the first national audit of acute inpatient services for stroke with 30 indicators, it became apparent that routine collection of many variables can be a burden for clinicians. Methods were needed to identify practical subsets of indicators that could be used for comparisons over time that reliably represented the 30 indicators. Value-based judgements to establish a subset were made by the National Advisory Committee (of the Stroke Foundation) using criteria such as level of evidence, clinical relevance, consumer importance, and ability for international comparisons. Various statistical analyses were undertaken to identify subsets that could predict patient outcome and total process score. Value-based judgments resulted in 14 indicators being selected; Statistical methods identified 12. Six indicators were consistently selected: stroke unit care; aspirin; physiotherapy assessment, and speech pathology assessment, within 48 hours; a care plan; and antihypertensive medication at discharge. It was found that selection of an indicator subset requires consideration of several factors. Indicators selected by experts were robust.

Adherence to clinical guidelines improves patient outcomes in Australian audit of stroke rehabilitation practice[50]

Little evidence exists to demonstrate the association between early intensive rehabilitation after stroke and functional improvement. In this study, the authors sought to publish the first study comparing adherence to recommended management in Australian rehabilitation units and stroke recovery outcomes. Using data collected for the 2008 Rehabilitation Audit, the authors investigated whether improved adherence to recommended management for stroke rehabilitation would lead to improved recovery outcomes for patients with stroke. Data were available on 2119 patients who were treated in 68 rehabilitation units participating in the audit. Evidence was presented to indicate that rehabilitation units providing evidence-based management were more likely to elicit better recovery outcomes for patients with stroke. The publication of these results was instrumental in highlighting the value of nationally agreed clinical guidelines and the importance of undertaking national audits to facilitate improvements in rehabilitation services for stroke.

Hospital processes of care can influence outcomes in patients with stroke and atrial fibrillation[52]

Few studies have been completed on the influence of hospital quality of care on stroke outcomes in patients with atrial fibrillation. With data from over 5400 patients (from 2009 and 2011 Acute Audits), variation of care and outcomes were identified for 2049 patients who had atrial fibrillation (Andrew et al. 2014). Atrial fibrillation was independently associated with in-hospital mortality (aOR 1·46, 95% CI 1·06, 2·02). Management on a stroke unit (aOR 0·57, 95% CI 0·40, 0·80) and having a swallow assessment within 24 h (aOR 0·71, 95% CI 0·51, 0·98) were associated with increased survival among all stroke types, as was receiving aspirin within 48 hours post stroke (aOR 0·65, 95% CI 0·44, 0·97), for patients with an ischaemic stroke. Stroke patients with atrial fibrillation were less likely to receive important processes of care associated with reduced mortality.

Hospitals admitting at least 100 patients with stroke a year should have a stroke unit[55]

Stroke unit care has been long recognised as a major component of providing effective stroke services for reducing death and disability after stroke. However, a gap in the literature surrounding whether these differences in mortality or other adverse outcomes between hospitals with similar admission numbers were due to treatment in a stroke unit or from patient differences. The aims of this study were to describe the current access to acute stroke units in Australia and to determine the differences in adherence to processes of care and in-hospital outcomes among hospitals with and without a stroke unit admitting at least 100 patients per year. Using data obtained from the 2011 Acute Audit, patient characteristics and process of care indicators were compared between patients with stroke admitted to a stroke unit hospital and a non-stroke unit hospital. Of the 188 hospitals that participated in the audit, 81 were classified as large hospitals that admitted at least 100 patients with stroke per year. Among these large hospitals, 2481 cases were from 60 hospitals with a stroke unit and 417 were from 12 hospitals without a stroke unit. Patients who were treated in a stroke unit were more commonly independent at admission, experienced less severe stroke and had fewer communication problems compared to those admitted to a non-stroke unit hospital. Non-stroke unit hospitals had reduced adherence to important processes of care (including provision of intravenous thrombolysis, allied health assessments, swallow screens and use of discharge plans) known to improve patient outcomes compared to hospitals with a stroke unit. Patients admitted to a stroke unit hospital were 37% (95% CI: 2 to 59%) less likely to have a new stroke whilst in hospital and had a 78% (95% CI: 65 to 86%) reduced odds of in-hospital mortality compared to patients treated in a non-stroke unit hospital. Patients treated in a stroke unit hospital were 63% more likely to experience minimal disability (modified Rankin Score of 0 to 2) compared to patients treated in a non-stroke unit hospital. Together these findings provided quantitative justification for why stroke units should be established in hospitals admitting at least 100 patients with stroke per year.

Hospital management and outcomes of stroke in Indigenous Australians[51]

The burden of stroke is significantly elevated among Indigenous Australians, with rates of hospitalisation and death 1.5 and 1.9 times greater than non-Indigenous Australians, respectively. Quality of hospital care is an important factor in influencing health outcomes post-stroke, however a lack of research has been undertaken to assess the variation in hospital care, and associated health outcomes, among Indigenous Australians. The aim of this study was to review hospital management and outcomes of Indigenous patients with stroke at a national level using data from the 2009 Acute Audit. Data from hospitals treating at least one Indigenous patient, aged 18-64 years, were obtained to capture a sample representative of the Indigenous population. For the analyses, patient characteristics, clinical processes of care and stroke outcomes were compared between Indigenous and non-Indigenous patients. Of the 96 Australian hospitals that participated in the clinical audit, 33 had audited at least one Indigenous patient with stroke aged 18-64 years. The final cohort consisted of 305 patients, with 53 (18%) identifying as Indigenous. Compared to non-Indigenous patients, Indigenous patients were significantly younger and more likely to have diabetes, report being a smoker, or report high-risk alcohol consumption. Indigenous patients were more likely to have experienced a haemorrhagic stroke and were also more likely to be incontinent within the first 72 hours of stroke onset than non-Indigenous patients (p=0.04). Compared to Indigenous patients, non-Indigenous patients were more likely to receive a variety of evidence-based processes of care including treatment in a stroke unit, aspirin within 48 hours (in ischaemic stroke), and allied health assessments within 48 hours. No Indigenous patient received intravenous thrombolysis. Health outcomes of Indigenous

patients were also poorer, with 22% more Indigenous patients dependent at time of discharge than non-Indigenous patients (p=0.016). This study has provided new and important evidence to show that the quality of clinical care within hospitals may be different based on Indigenous status, and this influences health outcomes. These findings have implications for clinicians and health administrators to review policies and practices for ensuring equitable quality of care for all patients admitted with stroke.

Improved in-hospital outcomes and care for patients in stroke research[53] (and corresponding letter)[54]

There is equivocal evidence about a 'trial effect' for patients with stroke (and other diseases) who participate in research, where results have the potential to influence trial recruitment and possibly drop-out rates. We used data from the national Acute Audit in 2009, 2011 and 2013 to determine if patients with acute stroke were more likely to receive recommended care processes and experience improved in-hospital outcomes compared to those who did not participate in research. It was shown that stroke research was more likely to be conducted in hospitals with a stroke unit, in urban areas and in hospitals admitting >200 patients with stroke annually. A total of 9537 records were included over the three cycles, with 469 (5%) involved in a research study (not defined if this was a randomised controlled trial, observational study or translational research, etc.) Those who participated in research were more likely to receive stroke unit care, which potentially would have contributed to an increased likelihood of receiving evidence-based care. However, even after adjusting for the effects of stroke unit care, greater access to timely allied health including physiotherapy (aOR 1.4 95% CI 1.2, 1.8) and speech therapy (aOR 1.3, 95% CI 1.1, 1.7) in 48 hours, behaviour change education (aOR 1.9 95% CI 1.5, 2.5) and other acute treatments such as thrombolysis (aOR 3.8 95% CI 2.5, 5.3) for research participants versus non-research participants was evident. Additionally, a potential improvement in in-hospital survival was seen (aOR 0.30 95% CI 0.12, 0.76). What we cannot say for sure is if being treated in a stroke unit increased the likelihood of being considered for research, or conversely, whether patients recruited to a research study were more likely to get access to a stroke unit. Regardless of the reason, spending more time on a stroke unit is clinically meaningful, as stroke unit care is the most universally applicable intervention known to improve outcome after stroke.

The potential health and economic impact of improving stroke care standards for Australia[23]

The costs and health benefits of improving the quality of stroke care to the achievable benchmarks in Australia were estimated. Data from the 2013 Acute Audit were utilised to calculate the overall proportions of patients who were provided treatment in a stroke unit, thrombolysis and the secondary prevention medications at discharge. These data were also utilised to calculate achievable benchmarks for the provision of these quality of care indicators using a methodology developed by Hall et al,[27] and used to estimate the number of patients in Australia who would receive these evidence-based therapies if the quality of stroke care was improved. The costs and benefits of providing these quality of care indicators were obtained from published literature. If the quality of stroke care at all hospitals in Australia was improved to that of the achievable benchmarks, it was estimated that 9329 disability-adjusted life years would be avoided at an additional cost of $3304 per disability-adjusted life year avoided

Influence of stroke coordinators on delivery of acute stroke care and hospital outcomes[57]

The role of stroke coordinators (SCs) has been inconsistently used in various countries to support stroke care in hospitals. However, there is limited indirect evidence from observational studies providing evidence of improved care and patient outcomes. Using data from the 2015 Acute Audit including 86 hospitals with a stroke unit, and 3405 cases, we were able to show that patients treated in stroke unit hospitals with a SC were more likely to receive recommended clinical practices including rehabilitation therapy within 48 hours, risk factor modification, and discharge care plans than patients from stroke unit hospitals with no SC. No differences in complications, independence or deaths were evident. However, results also demonstrated that patients at hospitals with a SC were more likely to access inpatient rehabilitation (aOR 1.8 95% CI 1.1, 2.8), and have a reduced length of stay (coefficient -0.6 95% CI -1.2, -0.2). Findings support the SC position in hospitals with a stroke unit, demonstrating the potential to positively impact delivery of coordinated and recommended evidence-based care.

Benefits of clinical facilitators on improving stroke care[44]

Variation in care is problematic, particularly in rural and regional locations where additional challenges related to limited infrastructure, resources and specialist staff need to be contended with. In 2007, only 21% of Australian hospitals had a stroke unit, with access as low as 50%. In 2007, the State Government of Victoria developed the Stroke Care Strategy that outlined recommendations to promote greater use of evidence-based interventions, including the fixed-term employment of a clinical facilitator (Facilitator program) in eight priority hospitals in metropolitan and regional locations across Victoria. Facilitators were nursing or allied health professionals with senior expertise in stroke, and were tasked with identifying gaps in existing care, and developing and executing a tailored implementation plan based on local priorities. To evaluate the impact of the Facilitator program, a mixed methods approach was undertaken including semi-structured focus group interviews with hospital staff and executives, and a historically controlled cohort study using national Acute Audit data collected from each of the eight hospitals. Overall, 2007 and 2009 Acute Audit data were combined and considered pre-Facilitator baseline data (n=600), which were compared with post-Facilitator data from the

2011 audit (n=387). We showed that access to stroke unit care increased almost six-fold (Pre 53% vs Post 86%) in the post-Facilitator period compared to pre-Facilitator. Changes were led primarily by the fact that only three hospitals had a formalised stroke unit prior to the program, with all establishing one during the period. Five sites reported providing thrombolysis infrequently prior to the program, with seven sites having a formalised protocol in place in the post-Facilitator period. These changes were reflected in the audit data, with thrombolysis rates increasing from 2% to 9% post-Facilitator. This study outlines a pragmatic way to leverage existing data from a national report to investigate change in practice at a more local level with success.

Is length of time in a stroke unit associated with better outcomes for patients with stroke in Australia? An observational study[56]

Clinically, it seems clear that spending longer in the stroke unit (SU) would be advantageous. Quality indicators related to 'spending 90% of the hospital admission in a stroke unit' have been reported both nationally and internationally. However, limited evidence exists supporting the association between time spent in the SU and improved patient outcomes. Data from the 2015 national Acute Audit, including hospitals with a SU, were used to determine if length of time in a stroke unit was associated with improved outcomes, and then, what factors were associated with spending at least 90% of the admission in the stroke unit. Of the 2655 cases, 64% spent at least 90% of their admission in the SU. As causality cannot be determined due to the study design, it was acknowledged that clinically certain outcomes, including length of stay, may be a consequence of experiencing a severe complication, suffering a more severe form of stroke, or delays in accessing the next stage of care. Nevertheless, we showed that those who spent at least 90% of their admission in the SU had a shorter length of stay (coefficient -2.77 95% CI -3.45, -2.10), fewer severe complications (aOR 0.60 95% CI 0.43, 0.84) and were less often discharged to residential care (aOR 0.59 95% CI 0.38, 0.94). Being admitted to the SU within 3 hours of arrival at the emergency department, and having 10 or more beds in the SU were factors associated with spending at least 90% of the admission in the SU. It is not just accessing the SU that is important, with these results showing that length of time is also important. These findings have implications for clinical practice and development of new models of stroke care, lending support to ensuring that all patients spend most of their admission in the SU.

5 Future directions

As highlighted in previous sections of Part D, there are aspects that could be implemented to enhance the existing data monitoring performed in Australia. The ability to spot audit at different time points, rather than just at the formal biennial timeline of the Audit Program, allows change in practice to be monitored after specific initiatives and in areas of interest. Having an independent endorsement process of hospitals meeting Framework criteria, specifically around stroke unit definitions, would also provide a quality check on the self-reported data, reducing the response bias and improving the validity of these data.

There is also further opportunity to advance the work around improving stroke care through data collection with the recent commitment made by the Federal Government to the National Heart and Stroke Action Plan. The Action Plan will be used to outline avenues for improvement in stroke prevention, diagnosis and treatment, recovery and support, and research initiatives to reduce the impact of stroke on the community and health care system.

Continuing data collection programs to monitor the quality of stroke care will identify areas of stroke care that can be improved upon and the data collected can also be utilised to assess the effects of quality improvement programs. Although the benefits of the audit and feedback in quality improvement are clear, how best to deliver the feedback is of interest. As outlined in Part C, the estimated advantages to the health of the Australian community from improving the quality of care provided in Australian hospitals were substantial, with relatively low additional costs to achieve the health benefits. Further improvements in the quality of care appear to be achievable and efforts to facilitate these improvements are likely to be cost effective and should be a focus in the future.

REFERENCES

1. Ebrahim S, Redfern J. *Stroke Care - a matter of chance. A national survey of stroke services*. London: Stroke Association; 1999.
2. National Health and Medical Research Council. *Prevention of Stroke*. Canberra: Australian Government Publishing Services; 1996.
3. National Stroke Foundation. *National guidelines for acute stroke management.* Melbourne: National Stroke Foundation; 2003.
4. Rudd AG, Irwin P, Rutledge Z, Lowe D, Wade D, Morris R, et al. The national sentinel audit for stroke: a tool for raising standards of care. *J R Coll Physicians Lond*. 1999;33:460-464
5. National Stroke Foundation. *Clinical guidelines for stroke management 2010.* Melbourne: National Stroke Foundation; 2010.
6. National Stroke Foundation. *National Acute Stroke Services Framework 2015*. Melbourne: National Stroke Foundation; 2015.
7. National Stroke Foundation. *Stroke Services in Australia: National Stroke Unit Program Policy Document.* Melbourne; 2002.
8. Australian Institute of Health and Welfare. *Rural, regional and remote health: A guide to remoteness classifications. Cat no PHE 53*. Canberra; 2004.
9. Bamford JM, Sandercock PA, Warlow CP, Slattery J. Interobserver agreement for the assessment of handicap in stroke patients. *Stroke*. 1989;20:828
10. Counsell C, Dennis M, McDowall M, Warlow C. Predicting outcome after acute and subacute stroke: development and validation of new prognostic models. *Stroke*. 2002;33:1041-1047
11. StataCorp. Statistical Software: Release 14. 2015
12. Australian Commission on Safety and Quality in Health Care. *Acute Stroke Clinical Care Standard*. Sydney: ACSQHC; 2015.
13. Wardlaw J, Murray V, Berge E, Del Zoppo G. Thrombolysis for acute ischaemic stroke. *Cochrane Database of Systematic Reviews*. 2104;7:CD000213
14. Stroke Foundation. *Clinical Guidelines for Stroke Management 2017*. Melbourne: Stroke Foundation; 2017.
15. Bladin CF, Molocijz N, Ermel S, Bagot K, Kilkenny M, Vu M, et al. Victorian Stroke Telemedicine Project: implementation of a new model of translational stroke care for Australia. *Internal Medicine Journal*. 2015;45:951-956
16. Cadilhac DA, Ibrahim J, Pearce DC, Ogden KJ, McNeill J, Davis SM, et al. Multicenter comparison of processes of care between Stroke Units and conventional care wards in Australia. *Stroke*. 2004;35:1035-1040
17. Stroke Unit Trialists' Collaboration. Organised inpatient (stroke unit) care for stroke *Cochrane Database of Systematic Reviews*. 2013;Art No.:CD000197
18. Cadilhac DA, Lannin N, Anderson C, Levi C, Faux S, Price C, et al. Protocol and pilot data for establishing the Australian Stroke Clinical Registry (AuSCR). *Int J Stroke*. 2010;5:217-226
19. National Stroke Foundation. *Clinical Guidelines for Stroke Rehabilitation and Recovery.* Melbourne: National Stroke Foundation; 2005.
20. National Stroke Foundation. *Rehabilitation Stroke Services Framework*. Melbourne: National Stroke Foundation; 2013.
21. Foley N, Salter K, Teasell R. Specialized stroke services: a meta-analysis comparing three models of care. *Cerebrovasc Dis*. 2007;23:194-202
22. Australian Institute of Health and Welfare. *Stroke and its management in Australia: An update*. Canberra: AIHW; 2013.
23. Kim J, Andrew NE, Thrift AG, Bernhardt J, Lindley RI, Cadilhac DA. The potential health and economic impact of improving stroke care standards for Australia. *Int J Stroke*. 2017;12:875-885
24. Stroke Foundation. *National Stroke Audit Acute Services Report 2017*. Melbourne: Stroke Foundation; 2017.
25. Australian Institute of Health and Welfare. *Cardiovascular disease snapshot*. AIHW; 2018.
26. Australian Bureau of Statistics. *3101.0- Australian Demographic Statistics, June 2018*. Canberra: ABS; 2018.
27. Hall RE, Khan F, Bayley MT, Asllani E, Lindsay P, Hill MD, et al. Benchmarks for acute stroke care delivery. *Int. J. Qual. Health Care*. 2013;25:710-718
28. Murray CJ. Quantifying the burden of disease: the technical basis for disability-adjusted life years. *Bull. World Health Organ.* 1994;72:429-445
29. Hong KS, Saver JL. Years of disability-adjusted life gained as a result of thrombolytic therapy for acute ischemic stroke. *Stroke*. 2010;41:471-477
30. Zonneveld TP, Richard E, Vergouwen MDI, Nederkoorn PJ, de Haan RJ, Roos Y, et al. Blood pressure-lowering treatment for preventing recurrent stroke, major vascular events, and dementia in patients with a history of stroke or transient ischaemic attack. *Cochrane Database Syst. Rev.* 2018
31. Rothwell PM, Algra A, Chen Z, Diener HC, Norrving B, Mehta Z. Effects of aspirin on risk and severity of early recurrent stroke after transient ischaemic attack and ischaemic stroke: time-course analysis of randomised trials. *Lancet*. 2016;388:365-375
32. Saxena R, Koudstaal PJ. Anticoagulants for preventing stroke in patients with nonrheumatic atrial fibrillation and a history of stroke or transient ischaemic attack. *Cochrane Database Syst. Rev.* 2004

33. Manktelow BN, Potter JF. Interventions in the management of serum lipids for preventing stroke recurrence. *Cochrane Database Syst. Rev.* 2009
34. Australian Institute of Health and Welfare. *Health expenditure Australia 2015-2016. Health and Welfare Expenditure Series. Number 58*. Canberra: AIHW; 2017.
35. Gloede TD, Halbach SM, Thrift AG, Dewey HM, Pfaff H, Cadilhac DA. Long-term costs of stroke using 10-year longitudinal data from the north East melbourne stroke incidence study. *Stroke*. 2014;45:3389-3394
36. Moodie M, Cadilhac D, Pearce D, Mihalopoulos C, Carter R, Davis S, et al. Economic evaluation of Australian stroke services: a prospective, multicenter study comparing dedicated stroke units with other care modalities. *Stroke*. 2006;37:2790-2795
37. Mishra NK, Ahmed N, Andersen G, Egido JA, Lindsberg PJ, Ringleb PA, et al. Thrombolysis in very elderly people: controlled comparison of SITS International Stroke Thrombolysis Registry and Virtual International Stroke Trials Archive. *BMJ*. 2010;341:c6046
38. Dewilde S, Annemans L, Peeters A, Hemelsoet D, Vandermeeren Y, Desfontaines P, et al. Modified Rankin scale as a determinant of direct medical costs after stroke. *Int. J. Stroke*. 2017;12:392-400
39. Marseille E, Larson B, Kazi DS, Kahn JG, Rosen S. Thresholds for the cost–effectiveness of interventions: alternative approaches. *Bull. World Health Organ.* 2015;93:118-124
40. Ivers N, Jamtvedt G, Flottorp S, Young JM, Odgaard-Jensen J, French SD, et al. Audit and feedback: effects on professional practice and healthcare outcomes. *Cochrane Database Syst Rev*. 2012:Cd000259
41. National Stroke Foundation. *Clinical guidelines for acute stroke management.* Melbourne: National Stroke Foundation; 2007.
42. Abilleira S, Ribera A, Permanyer-Miralda G, Tresserras R, Gallofre M. Noncompliance with certain quality indicators is associated with risk-adjusted mortality after stroke. *Stroke*. 2012;43:1094-1100
43. Victorian Government Department of Human Services. *Stroke care strategy for Victoria.* Melbourne; 2007.
44. Purvis T, Moss K, Francis L, Borschmann K, Kilkenny MF, Denisenko S, et al. Benefits of clinical facilitators on improving stroke care in acute hospitals: a new programme for Australia. *Internal medicine journal*. 2017;47:775-784
45. Cadilhac D, Dewey H, Denisenko S, Bladin C, Meretoja A. Changes in acute hospital costs after employing clinical facilitators to improve stroke care in Victoria, Australia. *BMC Health Services Research*. In Press;accepted 19/12/2018
46. Cadilhac D, Andrew N, Kilkenny M, Hill K, Grabsch B, Lannin N, et al. Improving quality and outcomes of stroke care in hospitals: Protocol and statistical analysis plan for the Stroke123 implementation study. *Int J Stroke*. 2018;13:96-106
47. French S, Green S, O'Connor D, McKenzie J, Francis JJ, Michie S. Developing theory-informed behaviour change interventions to implement evidence into practice: A systematic approach using the theorectical domains framework. *Implement Sci*. 2012;7:38
48. Harris D, Cadilhac D, Hankey GJ, Hillier S, Kilkenny M, Lalor E. National Stroke Audit: The Australian Experience. *Clinical Audit*. 2010;2:25-31
49. Cadilhac DA, Kilkenny M, Churilov L, Harris D, Lalor E. Identification of a reliable subset of process indicators for clinical audit in stroke care: an example from Australia. *Clinical Audit*. 2010;2:67-77
50. Hubbard IJ, Harris D, Kilkenny MF, Faux SG, Pollack MR, Cadilhac DA. Adherence to clinical guidelines improves patient outcomes in Australian audit of stroke rehabilitation practice. *Archives of physical medicine and rehabilitation*. 2012;93:965-971
51. Kilkenny MF, Harris DM, Ritchie EA, Price C, Cadilhac DA. Hospital management and outcomes of stroke in Indigenous Australians: evidence from the 2009 Acute Care National Stroke Audit. *Int J Stroke*. 2013;8:164-171
52. Andrew N, Kilkenny M, Harris D, Price C, Cadilhac DA. Outcomes for people with atrial fibrillation in an Australian national audit of stroke care. *Int J Stroke*. 2014;9:270-277
53. Purvis T, Hill K, Kilkenny MF, Andrew N, Cadilhac DA. Improved in-hospital outcomes and care for patients in stroke research. An observational study. *Neurology*. 2016;87:206-213
54. Purvis T, Cadilhac D. Observational studies and the chicken and the egg issue in stroke. *Nature Reviews Neurology*. 2016;Letter:doi:10.1038/nrneurol.2017.1059.
55. Cadilhac DA, Kilkenny MF, Andrew NE, Ritchie E, Hill K, Lalor E. Hospitals admitting at least 100 patients with stroke a year should have a stroke unit: a case study from Australia. *BMC Health Serv Res*. 2017;17:212
56. Busingye D, Kilkenny MF, Purvis T, Kim J, Middleton S, Campbell BCV, et al. Is length of time in a stroke unit associated with better outcomes for patients with stroke in Australia? An observational study. *BMJ Open*. 2018;8:e022536
57. Purvis T, Kilkenny MF, Middleton S, Cadilhac DA. Influence of stroke coordinators on delivery of acute stroke care and hospital outcomes: An observational study. *Int J Stroke.* 2018;13:585-591

APPENDIX

Published Abstracts

Cadilhac D, McGowan S, Purvis T, Hill K, Kilkenny M, Aslett T. Services for stroke care across Australia from 1999 to 2017: are we there yet? International Journal of Stroke 2018; Vol. 13(2S):p59

Purvis T, Middleton S, Craig L, Kilkenny M, Dale S, Hill K, D'Este C, Cadilhac D. Greater adherence in fever, hyperglycaemia, and swallowing (FESS) management for patients with acute stroke across Australia: an observational study International Journal of Stroke 2018;Vol.13(1S):p17

Hill K, Purvis T, Kilkenny MF, Reyneke M, Aslett T, Maxwell J, Cadilhac D. Metropolitan-regional stroke care divide – are we closing the gap? International Journal of Stroke 2018;Vol.13(1S):p18

McGowan S, Cadilhac D, Purvis T, Hill K, Reyneke M, Aslett, Kilkenny M. The changing landscape of stroke services in Australia: almost two decades of organisational survey data. International Journal of Stroke 2018; Vol.13(1S):p41

Purvis T, Kilkenny MF, Young P, Watkins J, Cadilhac DA. Adherence to the National Rehabilitation Framework influences quality of care and patient outcomes: the Australian experience. International Journal of Stroke 2017, Vol. 12(3S):p25

Purvis T, Kilkenny MF, Middleton S, Cadilhac D. Do stroke coordinators influence the delivery of acute care and hospital based patient outcomes? International Journal of Stroke 2017 Vol. 12(2S):p10.

Purvis T, Kilkenny MF, Young P, Watkins J, Cadilhac D. Mood impairment and psychological assessment in stroke rehabilitation in Australia. International Journal of Stroke 2017 Vol. 12(2S):p18

McGowan S, Hill K, Young P, Cadilhac D, Kilkenny M, Purvis T. Mood impairment and psychological assessment in rehabilitation. European Stroke Journal 2017; 2(1S):416[Poster]

McGowan S, Hill K, Young P, Cadilhac D, Kilkenny M, Purvis T. "Falling into a black hole'' – the need for improvement in discharge care planning for stroke survivors. European Stroke Journal 2017; 2(1S):409 [Poster]

K Hill, T Purvis, M Kilkenny, E Ritchie, D Cadilhac, E Lalor. Levels of adherence to the National Stroke Rehabilitation Framework recommended elements. International Journal of Stroke 2015, 10 (S3):11

D Cadilhac, B Gardner, T Purvis, J Ponsford, R Stolwyk. Improving access to psychology services in Australian rehabilitation hospitals: Could a telemedicine service be feasible? International Journal of Stroke 2014; 9(S3): 219

D Cadilhac, T Purvis, K Hill, R Stolwyk. Access to psychology services in Australian rehabilitation hospitals: Understanding disparities based on location and impacts on care in hospital. International Journal of Stroke 2014; 9(S3):257

T Purvis, E Ritchie, M Kilkenny, K Hill, E Lalor, D Cadilhac. Discharge planning and support for survivors and carers in acute stroke. International Journal of Stroke 2014; 9(S2): 10

T Purvis, E Ritchie, M Kilkenny, K Hill, E Lalor, S Middleton, D Cadilhac. National management of fever, hyperglycaemia and swallow in acute stroke. International Journal of Stroke 2014; 9(S2): 21

K Hill, T Purvis, E Ritchie, M F Kilkenny, N Andrew, L Churilov, E Lalor, D Cadilhac. Hospital organisational factors associated with decreased door to needle time. International Journal of Stroke 2014; 9(S1): 17

Cadilhac D, Andrew N, Hill K, Kilkenny M. Do patients with stroke enrolled in research do better? (ABSTRACT 240) Neuroepidemiology; 2013;41:269 doi 10.1159/000356326

Purvis T, Ritchie E, Kilkenny M, Price C, Hill K, Lalor E, Cadilhac D, On behalf of the National Stroke

Foundation and the National Stroke Audit Collaborative. Mood impairment and psychological assessment in rehabilitation. International Journal of Stroke 2013; 8(Suppl 2): 16

Purvis T, Ritchie E, Kilkenny M, Price C, Hill K, Lalor E, Cadilhac D, On behalf of the National Stroke Foundation and the National Stroke Audit Collaborative Institutions. Support offered to carers of stroke survivors in rehabilitation. International Journal of Stroke 2013; 8(Suppl 2): 24

DA Cadilhac, T Purvis, E Ritchie, MF Kilkenny, C Price, K Hill, E Lalor. Community rehabilitation of stroke survivors and follow-up. International Journal of Stroke 2013; 8(Suppl 1): 19

K Hill, T Purvis, E Ritchie, MF Kilkenny, C Price, E Lalor, DA Cadilhac. Management of impairments in rehabilitation. International Journal of Stroke 2013; 8(Suppl 1): 22-23

D.A. Cadilhac, T. Purvis, E. Ritchie, M. Kilkenny, C. Price, K. Hill, E. Lalor On behalf of the National Stroke Foundation and the National Stroke Audit Collaborative Institutions. Secondary prevention in the rehabilitation setting. Cerebrovascular Diseases 2013; 35(Suppl 3): 166

Kilkenny M, Price C, Cadilhac DA, Andrew NE, Ritchie E, Harriss L, on behalf of the National Stroke Foundation National Advisory Committee and the National Stroke Audit Collaborative (2012). What are the differences in clinical care quality among hospitals admitting 100 or more patients per year? [P3] International Journal of Stroke 7(Supplement 1): 34

Kilkenny M, Cadilhac DA, Andrew NE, Ritchie E, Harriss L, Price C, on behalf of the National Stroke Foundation and the National Stroke Audit Collaborative (2012). Improvements in quality of care for stroke patients between 2009 and 2011. [P4] International Journal of Stroke 7(Supplement 1): 35

Kilkenny M, Harris D, Ritchie E, Price C, Harriss L, Cadilhac D (2011). Tracking quality of stroke rehabilitation discharge planning in Australia. [O48] International Journal of Stroke 6(Supplement 1): 16.

Hubbard I. J., Harris D, Kilkenny, M.F., Faux S.G., Pollack, M.R.P., Cadilhac D.A. (2011). Australian clinical practice of inpatient stroke rehabilitation and its relationship to patient outcomes. [O50] International Journal of Stroke 6(Supplement 1): 17.

Cadilhac D, Harris D, Kilkenny M, Ritchie E, Price C, Lalor E (2010) Changes in organisation of Australian stroke care, the past 10 years. Int J Stroke. 5(Supplement 1), September.

Harris, D., Cadilhac, D. A., Faux, S., Gillis, C., Hubbard, I., Kilkenny, M., Lever, S., Pollack, M., & Price, C. (2009b). Stroke rehabilitation in Australia: audit 2008 results. [ABSTRACT A8]. Int J Stroke, 4 (Suppl.1), 21.

Cadilhac DA, Hankey G, Harris D,, Hillier S, Kilkenny M, Lalor E. The Australian national clinical audit of acute hospital stroke services. Internal Medicine Journal 38 (Supplement 4), August 2008.

Cadilhac, D.A, Hankey, G., Harris D., Hillier, S., Kilkenny. M., and Lalor,E. The inaugural Australian national audit of acute hospital services: determining adherence to clinical recommendations with Level 1 evidence. Cerebrovasc Dis 25(suppl 2):76 Abstract 16 Acute stroke: clinical patterns and practise. May 2008

Abstracts in Conference Proceedings

Cadilhac DA, Moss K, Purvis T, Kilkenny M, Borschmann K, Francis L. Evaluating the outcomes of the Victorian Stroke Clinical Network (VSCN) placements of Stroke Network Facilitators in selected health services. The Australasian Clinical Networks Conference, Sydney 21-23 November 2012.

Poster Presentations (not mentioned in other sections)

D.A. Cadilhac, T. Purvis, K. Moss, K. Borschmann, L. Francis, M.F. Kilkenny, on behalf of the Victorian Stroke Clinical Network. Enhancing stroke care in Australian hospitals: experience from the Victorian Stroke Clinical Network program. 8th World Stroke Congress, Brasilia, Brazil, 10-13 October 2012.

About 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. We support survivors on their journey to live the best possible life after stroke.

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SF226_0319