

Stroke Clot Retrieval

A National Service Improvement
Programme Action Plan

2021

Acknowledgements

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Contents

Introduction	1
Case for change	2
Stroke	2
Stroke clot retrieval	2
Treatment outcomes	3
Improving equity	6
A plan for stroke clot retrieval	8
Objectives	8
Principles	9
The service model for stroke clot retrieval	10
Priority areas for improvement	17
Measures	18
System enablers	19
Implementation approach	43
Evaluation	44
Glossary of abbreviations	46
Appendices	47
Appendix 1: Modified Rankin Scale	47
Appendix 2: Post-stroke clot retrieval procedure observations	48
References	49
List of Figures	
Figure 1: Principles for stroke clot retrieval services	9
Figure 2: Stroke clot retrieval service model	10
Figure 3: Pathway requirements	13
Figure 4: Flight times to a stroke clot retrieval centre	15

List of Tables

Table 1:	EXTEND-IA trial mRS for 50 treated patients	5
Table 2:	EXTEND-IA length of stay	6
Table 3:	IV alteplase in DHBs with a high proportion of Māori, Pacific people or quintile 5 residents	7
Table 4:	System enablers	19
Table 5:	Priority area 1: Ensure that care is patient-centred, culturally appropriate, high-quality and safe	27
Table 6:	Priority area 2: Reduce transfer delays	31
Table 7:	Priority area 3: Improve radiology access, capacity and capability	35
Table 8:	Priority area 4: Enabling implementation of telestroke	38
Table 9:	Priority area 5: Enable safe, sustainable stroke clot retrieval services	42

Introduction

The New Zealand Strategy for Endovascular Clot Retrieval (the Strategy) was developed by a working group under the direction and governance of the National Stroke Network (NSN). The working group was convened in 2016 and tasked with developing a national implementation strategy for acute ischaemic stroke (AIS) patients who require stroke clot retrieval (SCR).

AIS is one form of stroke; the term refers to sudden blockage of a major brain artery, usually from a clot from the heart or neck moving into the brain. As it enters the brain, the clot lodges in the vessel at the point where it is larger than the vessel diameter. The clot causes slowing or complete interruption of blood flow to the brain, which in turn becomes deprived of oxygen.

SCR is the removal of the clot from the artery by an endovascular technique. It involves deep sedation or general anaesthesia, followed by access to the body's arteries through the groin. After gaining access to the arteries, devices are navigated under x-ray into the blocked artery, and a basket-type device deployed into the clot and retrieved, pulling the clot with it (Sydney Neurointerventional Specialists 2017).

International stroke guidelines recommend SCR as a standard of care in international stroke guidelines; it is being provided in New Zealand on an ad hoc basis. The treatment has substantial benefits in terms of improved outcomes following stroke. For the treatment to be successful, it is essential for the patient suffering from stroke to be transferred to hospital as quickly as possible, since the benefit for treatment falls after six hours after the onset of symptoms.

Removal of clots blocking large arteries that supply blood to the brain results in one more person able to go home and live independently for every five treated, and one person better than they would have been for every 2.6 treated (ECR Working Group 2016)

The 2016 Strategy includes:

- protocols of care for people being considered for and treated with SCR, including:
 - patient selection criteria in a New Zealand setting
 - inter-hospital transfer strategies
 - care of patients being considered for and treated with SCR
- a description of the minimum staffing requirements for SCR services (neurologist/stroke physician, neurointerventionalist (who perform SCR), anaesthetists and nursing staff)
- cost efficacy based on an estimate of likely patients over the next five years
- optimal treatment site number and locations, initially and after five years.

Case for change

Stroke

Stroke is reported to be the second most common cause of death worldwide, after ischaemic heart disease. It caused 6.24 million deaths globally in 2015, up from 5.41 million deaths in 2000 (World Health Organization 2017). Those who survive stroke are often left with major long-term disability.

Lifetime costs per stroke patient in New Zealand are estimated to be \$73,600 per person (Brown 2009). The total annual lifetime costs of stroke to New Zealand is estimated to be \$450 million (Child et al 2011). Stroke costs are reported to be greatest for ischaemic stroke, driven by variation in hospital length of stay in the first year (Dewey et al 2003).

Until recently, intravenous (IV) thrombolysis with alteplase was the only treatment shown to open occluded vessels and improve clinical outcome (Jauch et al 2013; Wright et al 2012; Stroke Foundation of New Zealand 2010).

Thrombolytic therapy has a number of limitations. Therapy needs to start within 4.5 hours of symptom onset, and alteplase is not effective at dissolving large proximal clots. Recanalisation rates are less than 10 percent for distal internal carotid artery occlusion and approximately 30 percent for proximal middle cerebral artery (M1) occlusion (Riedel et al 2011). Around 60–80 percent of patients are dead or dependent at 90 days after the stroke, despite this therapy (Barber et al 2015).

SCR, used in clinically appropriate cases, will promote optimum recovery, improved independence and reduced complications and therefore results in a reduced stroke burden (in clinical, social and financial senses) overall.

Stroke clot retrieval

SCR is an adjunct to thrombolytic therapy, and needs to be provided as part of a comprehensive stroke, neurointervention and imaging service.

For SCR to be considered, stroke pathways need to be well developed in all district health boards (DHBs) and hospitals, within an effective 24/7 acute stroke service. Regional ambulance services should use defined hyper-acute stroke pathways, rapid access to computed tomography (CT) imaging, including CT angiography (CTA) and CT perfusion (CTP), should be available, to enable timely decision-making about commencing IV thrombolysis. A 24/7 acute stroke service will require reliable access to facilities, imaging and specialist resources. Some upfront DHB investment will be necessary, to achieve long-term benefits to individual patients and the system itself.

Regions that do not have the resources to provide 24/7 acute stroke care should be supported through the use of telestroke services.

The cost of providing stroke clot retrieval

During 2018/19, the National Costing Collection Pricing Programme (NCCPP) assessed costing data submitted for SCR provided in New Zealand in previous years (NCCP Casemix-Cost Weights Project Group 2019). A New Zealand diagnostic related group (DRG)¹ has been created – B02W Stroke Clot Retrieval – for use in 2019/20. The average case weighted discharge assigned to B02W in 2019/20 is 7.53, which attracts approximately \$40,000 per discharge. Over time this may increase as providers transition to an established 24/7 SCR service and report the associated costs.

In New Zealand, the DHB where the patient lives funds treatment, irrespective of where that treatment is provided. This means that provider DHBs will recuperate the cost of SCR services from referring DHBs through inter-district flow (IDF) funding. The DHBs where patients live will gain benefits from reduced medical, rehabilitation and long-term residential care costs.

Treatment outcomes

As it is internationally, stroke is one of the leading causes of death or health loss in New Zealand (Ministry of Health 2016(a); Ministry of Health 2016(b)). For people aged 65–74 years, stroke accounts for 4 percent of health loss. For people aged 75 and over, it accounts for 7 percent of health loss.

Stroke incidence and mortality are both declining, however mortality is declining faster than incidence, suggesting that New Zealand can expect a rise in stroke prevalence and disability over the next 10 years (Ministry of Health 2016(a)).

We can reduce the burden of stroke and improve people's quality of life through better management of AIS with more efficient recognition and clinical pathways. The Ministry of Health (the Ministry) is supporting improved pathways through a range of strategies, including the use of telehealth and enhanced access to IV thrombolysis. The New Zealand strategy for SCR is intended to supplement the stroke pathway work.

¹ DRGs are designed to reflect a systematic grouping of clinically similar events that have comparable resource use. DRGs enable hospital production to be measured by linking characteristics of patients treated, and the resource used in treating their patients to determine a weighted discharge value.

Improved health outcomes

In early 2015, five landmark studies (Berkhemer et al 2015; Goyal et al 2015; Campbell et al 2015; Saver et al 2015; Jovin et al 2015) reported the clear superiority of SCR over standard therapy (IV thrombolysis). The evidence from these studies is outlined in the Strategy (ECR Working Group 2016) and in the health technology assessment undertaken by HealthPACT in Australia (Queensland Department of Health 2015).

The five studies showed improved outcomes following SCR compared with standard therapy, using the modified Rankin Scale (mRS); a scale of 0–6 in which 0 is symptom free and 6 signifies death (see Appendix 1).

Specifically, the five studies found the following:

- for every 2.6 people treated with SCR, one person had an improvement of at least one point on the mRS (ie, 38 percent had at least a one-point reduction in mRS score)
- for every five people treated with SCR, one more person was alive and independent (mRS of 0–2) at 90 days (ie, 20 percent were alive and independent at 90 days)
- for every six people treated with SCR, one less person was left severely disabled (mRS of 4–5) and requiring hospital-level residential care (ie, 17 percent were less disabled).

Reduction to health system costs

In New Zealand, the cost to the health system for long-term residential care varies according to the region, the level of care required (either rest home or hospital) and individuals' assets/ability to pay. Residential care is means tested; people with assets above the threshold are required to fund their residential care at the maximum contribution level (which ranged from \$974 to \$1063 per week in 2017, depending upon DHB region). People whose assets are below the threshold receive subsidised residential care.

The Ministry's statistics show that around 65 percent of individuals in residential care have the majority of the cost of their care subsidised by their DHB, and contribute only their income (usually superannuation). The average DHB contribution to rest home care is \$18,000 per person per annum. The average DHB contribution to hospital-level care is \$44,000 per person per annum.

The EXTEND-IA trial (Campbell et al 2015) showed improvements that can demonstrate the impact of SCR on reducing dependence on rest home care following stroke.

Table 1: EXTEND-IA trial mRS for 50 treated patients

mRS	0	1	2	3	4	5	6	0-2	3-5
SCR+IV alteplase	26%	26%	20%	17%	3%	0	9%	72%	20%
No. if 50 treated	13	13	10	9	2	0	5	36	11
IV alteplase only	17%	11%	11%	11%	17%	11%	20%	39%	33%
No. if 50 treated	9	6	6	6	9	6	10	20	20

The EXTEND-IA trial showed that 72 percent of people treated with thrombolytics and SCR had a mRS score of 0–2 (ie, were essentially independent), compared to 39 percent in the control group, which received only thrombolytics (Campbell et al 2015). The identified improvements from this study have been used to estimate potential savings to DHBs in New Zealand.

Increased independence among stroke survivors

The health system would achieve savings through reduced dependence on aged residential care if an extra 33 percent of people treated with SCR were able to live independently or with minimal support (ie, had a mRS score of 0–2).

In terms of long-term residential care, the Strategy estimated savings of \$397,280 per annum based on eight fewer patients with mRS scores of 4 or 5 at day 90, assuming \$49,660 per person as the average cost of long-term residential care in Auckland (ECR Working Group 2016). In terms of hospital-level care, it estimated savings of \$350,000 per annum for eight fewer patients, or \$700,000 for 16 fewer patients, using a national average of \$44,000 per person for this level of care. These savings do not take into account savings associated with reduced hospital stay.

Fewer severely disabled stroke survivors

For every 50 patients treated with SCR per year, there would be 10 fewer people left moderately to severely disabled at 90 days after their stroke (ie, with an mRS score of 3–5) and requiring residential care.

People with a mRS of 4 or 5 are likely to require hospital-level care, while many people with a mRS of 3 will require rest home care.

Assuming that all people with a mRS of 3 will require rest home care (at a cost to DHBs averaging \$18,000 per person per year), and that those with a mRS of 4 or 5 will require hospital-level care (at a cost to DHBs averaging \$44,000 per person per year), the net savings from every 50 people treated with SCR is around \$500,000 per year.

Hospital and rest home savings are cumulative; savings accrue for each year of rest home care saved.

Reduced time in hospital

While the hospital cost of providing SCR is relatively high, this can be offset not only by the residential care savings reported above, but also by the savings associated with a reduced acute hospital length of stay following AIS. Table 2 shows the EXTEND-IA study finding that following SCR people generally spent less time in hospital (Campbell et al 2015).

Table 2: EXTEND-IA length of stay

	Acute median	Rehabilitation median	Total median	Total range
SCR+IV alteplase	8 days	14 days	17 days	4–43 days
IV alteplase only	12 days	33 days	75 days	21–90 days

Reduced hospital stay will be associated with significant benefits for DHBs in terms of the cost of treating patients and additional capacity available for other patients.

Improving equity

Māori and Pacific peoples experience stroke at a significantly younger age (at a mean age of 60 and 62 respectively) compared to New Zealand Europeans (at a mean age of 75). These population groups also have the slowest rates of decline in stroke incidence and mortality (Ministry of Health 2016(a)).

Stroke is linked to high blood pressure, which is influenced by factors such as high intake of salt and alcohol and low rates of physical activity. Smoking is another contributing factor, causing 40 percent of all strokes in people aged under 65 years (Ministry of Health 2016(a)). Addressing stroke risk factors is key in reducing incidence of stroke in Māori and Pacific peoples.

According to the distribution of IV alteplase use reported in the Strategy, the regions with the best access to this treatment are those with large metropolitan populations, such as Auckland, Waikato, Capital & Coast and Canterbury. In general, DHB regions with large Māori or economically deprived populations have the lowest rates of alteplase use (Table 3).

Table 3: IV alteplase in DHBs with a high proportion of Māori, Pacific people or quintile² 5 residents

DHB	2015 IV alteplase	DHB % of national IV alteplase	DHB % Māori and Pacific	DHB % quintile 5
Tairāwhiti	5	1%	53%	48%
Lakes	1	0%	37%	34%
Northland	8	2%	35%	38%
Counties Manukau	10	3%	35%	36%
Hawke's Bay	11	3%	30%	28%
Whanganui	2	1%	29%	37%

Note: Of these DHBs, only Counties Manukau has a Pacific population that is greater than the Māori population (21% Pacific). The other DHBs with large Māori populations have a Pacific population that is between 1 and 4 percent.

While there may be many reasons for lower use of IV alteplase, including higher stroke mortality, distance from a major centre or larger proportion of the population that is rural, ensuring Māori and Pacific peoples have similar access to both thrombolysis and SCR is important, to ensure the equity gap in stroke outcomes does not widen.

A recent NSN review of thrombolysis in Māori found that, across the country, the thrombolysis rate was similar for Māori and non-Māori (9.7 percent for Māori and 8.2 percent for non-Māori), which is reassuring. None the less, it remains a fact that DHBs with a high rate of Māori residents have the lowest thrombolysis rates; this remains a concern. We currently lack reliable information on Pacific peoples thrombolysis rates, but this data is in the process of being collected.

² Quintiles measure socioeconomic deprivation; Quintile 1 represents people living in the least deprived 20 percent of areas, and Quintile 5 represents people living in the most deprived 20 percent of areas.

A plan for stroke clot retrieval

This section describes the action plan to ensure people with AIS who have the potential to benefit from SCR receive high-quality care and equitable services. The objectives for SCR provision and the principles that underpin service delivery are described, along with the service configuration and key elements of the service model. Priority areas for improvement, to achieve SCR objectives are also identified.

Objectives

The objectives of this action plan are to:

1. improve access to SCR
2. reduce inequity of access to SCR
3. provide patient-centred, culturally appropriate care
4. improve health outcomes
5. improve equity in outcomes.

To achieve these objectives minimum requirements for SCR services are that these:

- are nationally consistent
- are sustainable and available 24 hours
- are supported by an appropriately skilled workforce
- make optimal use of technology.

Improving outcomes for Māori underpins the Action Plan for SCR, given the inequity of Māori health outcomes relative to non-Māori. The Action Plan supports improving Māori health by focusing on reducing inequity of access and health outcomes, while supporting the efforts of DHBs and ambulance services to strengthen the Māori health workforce. The Action Plan acknowledges the obligations of all health providers to Māori under the Treaty of Waitangi.

Principles

The principles for provision of SCR services will align with the five themes of the New Zealand Health Strategy: people-powered, closer to home, value and high performance, one team and smart system.

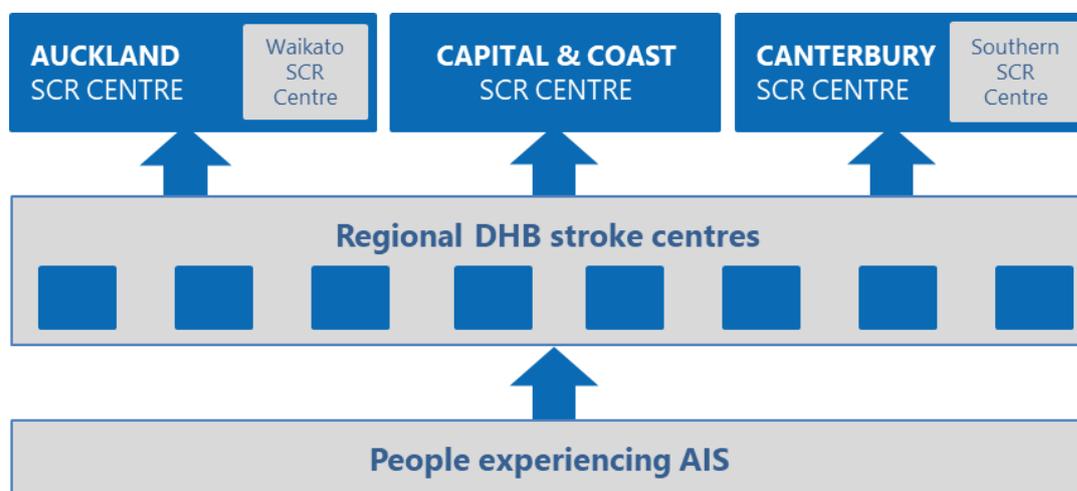
Figure 1: Principles for stroke clot retrieval services

<p>People-powered Mā te iwi hei kawē</p>	<p>Our vision: People experiencing stroke will be able to access the best available stroke therapies through regional networks. They and their whānau will participate in joint decision making about their emergency treatment decisions and ongoing care. People will be empowered to recognise stroke symptoms early and implement effective preventative strategies.</p>
<p>Closer to home Ka aro mai ki te kāinga</p>	<p>Our vision: People experiencing stroke and SCR will be supported by strong regional networks that allow an early return to their home DHB following treatment. Telestroke networks will ensure that people are only transferred for SCR if they are very likely to benefit, reducing unnecessary disruption.</p>
<p>Value and high performance Te whāinga hua me te tika o ngaā mahi</p>	<p>Our vision: SCR will provide highly cost-effective treatment for people experiencing stroke, providing better outcomes and overall health sector savings. SCR services will support equity of access and outcomes so that people are not disadvantaged if they live in rural settings or a distance from a stroke or SCR centre. Key performance indicators and a quality assurance programme will ensure that patients receive closely monitored, high-quality care.</p>
<p>One team Kotahi te tīma</p>	<p>Our vision: SCR services will adopt a one-team approach, ensuring multidisciplinary and multiagency provision of stroke education, prevention and treatment. The SCR team will be committed to delivering better outcomes for people experiencing stroke, maximising equity, efficiency and collaboration. The SCR team will work collaboratively to use available data to support evidence-based implementation of services.</p>
<p>Smart system He atamai te whakaraupapa</p>	<p>Our vision: The SCR model of care will use telestroke technology to connect the multidisciplinary team so that timely treatment decisions can be made that benefit patients and their whānau. SCR services will utilise a web-based register that is accessible to clinicians and that supports the quality assurance programme and improved outcomes for people experiencing stroke.</p>

The service model for stroke clot retrieval

The strategy recommended the following approach for SCR services as the best solution to ensure safety, efficacy, cost-effectiveness and equity of access.

Figure 2: Stroke clot retrieval service model



Stroke clot retrieval centre roll-out

The strategy envisages a roll-out of SCR centres throughout New Zealand in two phases. The first phase entails a two-year plan for regional centralisation of 24/7 SCR services within three initial sites:

- Auckland DHB (Auckland City Hospital) – the expected referring stroke centres will be from the Northern and Midland Region DHBs, excluding Taranaki after mid-2019
- Capital & Coast DHB (Wellington Regional Hospital) – the expected referring stroke centres will be from Central Region DHBs, as well as Nelson Marlborough DHB, and Taranaki DHB by mid-2019
- Canterbury DHB (Christchurch Hospital) – the expected referring stroke centres will be from South Island DHBs, with the exception of Nelson Marlborough DHB.

People may be referred to an SCR centre from outside the usual catchment area if SCR eligibility requirements can be met, the usual SCR centre cannot provide service, or transport is not feasible (eg, due to weather) and another centre can provide treatment.

The second phase entails a five-year plan to:

- establish a regional 24/7 SCR service at Waikato Hospital (based on the assumption that national volumes can support a fourth centre in a few years' time)
- review stroke thrombolysis volumes in Southern DHB to determine whether there would be sufficient SCR volume to support a clinically safe 24/7 service in Dunedin Hospital.

Who can receive stroke clot retrieval?

Eligibility for SCR is determined between the stroke physician and the SCR service following review of individual patients and CT images, taking into account time from stroke and expected time to arrive in the SCR centre.

People may be clinically eligible for SCR when they were previously independent (ie, had an mRS score of 0, 1 or 2), present with potentially disabling neurological deficits, have evidence of a relevant blood vessel occlusion on imaging, and have a clearly defined onset of symptoms or favourable CTP imaging (ie, small core).

In addition to clinical suitability, there are three requirements that need to be met if SCR is to be considered.

1 Transferred within treatment timeframes

Potential candidates need to be transferred to an SCR centre for treatment within the six-hour timeframe. Commencement of groin puncture must occur:

- within six hours from onset of symptoms, if there is internal carotid artery territory ischaemia
- within 12 hours, if there is basilar occlusion territory ischaemia (noting the treatment window can extend up to 24 hours in selected cases)
- within 24 hours, if additional imaging criteria using CTP are met.

An effective 'door-to-treatment' procedure requires prompt presentation, rapid diagnosis and efficient clinical decision-making. It also requires good public awareness of stroke symptoms, prompt transfer services and a well-trained, well-supported workforce outside of the SCR centres.

2 Have commenced thrombolytic treatment

Most people considered for SCR will have commenced thrombolytic treatment to dissolve the clot. Again, this requires swift transfer to a stroke centre and appropriate clinical decision-making. Telestroke is an important enabler of the timely decision-making required to ensure early thrombolytic treatment and potential access to SCR.

A proportion of people who are not eligible for IV alteplase will still benefit from SCR. These people should consider on a case-by-case basis.

3 Have had computed tomography imaging to assess inclusion/exclusion criteria

Eligibility and exclusion criteria for SCR are described in the strategy as:

Inclusion criteria

CT scan, CT angiography (CTA) and, in at least a subset of patients, CT perfusion (CTP) imaging is required to confirm suitability for SCR. This requires DHBs where patients present with AIS to have 24-hour access to CT imaging with clear radiology protocols in place to fast-track SCR candidates. Patients presenting outside the six-hour window should be considered for imaging with CTP, which may also be useful in the sub-six-hour window.

Imaging should demonstrate an arterial occlusion in the carotid artery termination, M1 segment middle cerebral artery, or all M2 branches, or in a basilar artery. Once imaging has been completed the results need to be interpreted, either by a radiologist or suitably skilled neurologist.

Exclusion criteria

Imaging will also identify where SCR is not suitable or is contra-indicated. Exclusion criteria is evidence of a large infarct core, determined by:

- non-contrast CT brain scan, ASPECT score < 6
- CT perfusion scan infarct core of greater than 70cm³
- a matched infarct core and perfusion deficit on CT perfusion studies is a relative contra-indication to SCR.

People with evidence of cervical artery dissection or occlusion may be considered for treatment on a case-by-case basis (ECR Working Group 2016).

What is required to achieve stroke clot retrieval objectives?

A number of considerations went into designing the model for New Zealand service provision as contained in the strategy these are critical to achieving the following SCR objectives.

1. **Time-critical requirements:** Studies have shown that SCR is most effective if groin puncture is started within six hours after symptom onset. However, the sooner a blood vessel can be opened, the better a person's chance of an improved outcome.
2. **The requirement for equitable access:** SCR centres need to be sited so that all New Zealanders are able to reach a centre within six hours of the onset of stroke symptoms, staff them to provide a 24/7 on-call roster, and ensure they treat at least 30 patients per year.
3. **The requirement for 24/7 availability:** An SCR centre will require at least three neurointerventionalists to maintain a one-in-three on-call roster, but ideally have four, to allow for leave and a more sustainable service.

4. **The requirement for highly skilled neurointerventionalists:** A 2013 study using the United States National Inpatient Sample found that increased clot retrieval case load was associated with reduced mortality after adjustment for baseline clinical status (Adamcyk et al 2013). To maintain adequate technical skills, neurointerventionalists need to perform this procedure in a minimum of 10 cases per year.

1 Time-critical requirements

One of the main constraints impacting on eligibility for SCR is requirement that treatment must occur within six hours of the stroke event. The time of day the stroke occurs and the geographical location of the patient may make it difficult for many people who could benefit from SCR to access this treatment.

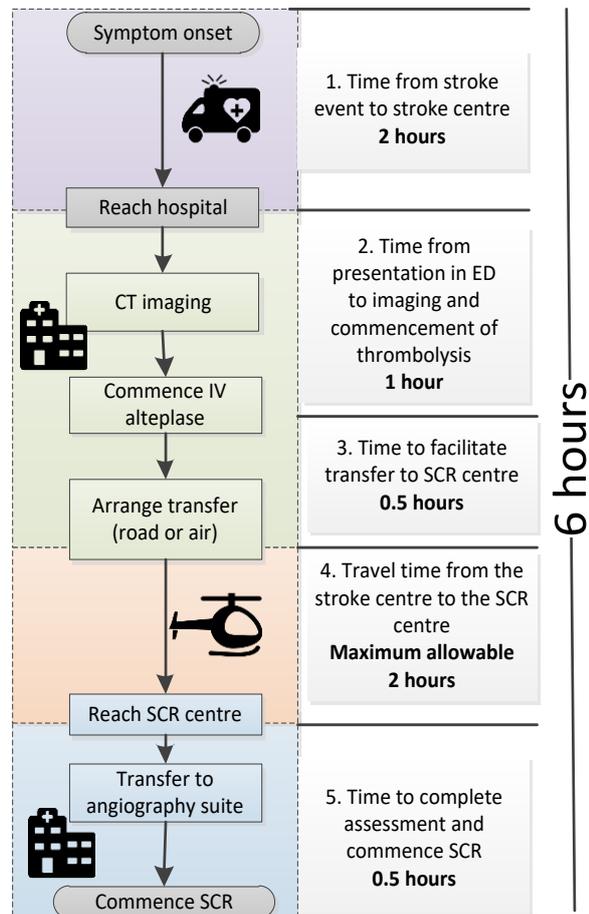
The time critical requirements in a stroke/SCR pathway are:

- time from stroke event to reaching a stroke centre
- time from presentation in the emergency department (ED) to completing CT imaging, and from review of imaging to decision to treat (thrombolysis and/or SCR)
- time to facilitate transfer to an SCR centre (if the person is not already in one), including tasking of appropriate transport, and staffing
- travel time from the stroke centre to the SCR centre
- time taken to complete the final assessment upon arrival in the SCR centre and ensure availability of required staff and the theatre/ angiography suite.

The SCR pathway in Figure 3 considers each of these elements and assigns an estimated reasonably achievable time for each step. The more streamlined each pre-hospital or hospital element becomes over time, the more inter-hospital transport time will be available, increasing the number of people who can benefit from SCR.

There are four particular settings involved in the pathway illustrated in Figure 3, each entailing distinct actions, staff roles and time frames.

Figure 3: Pathway requirements



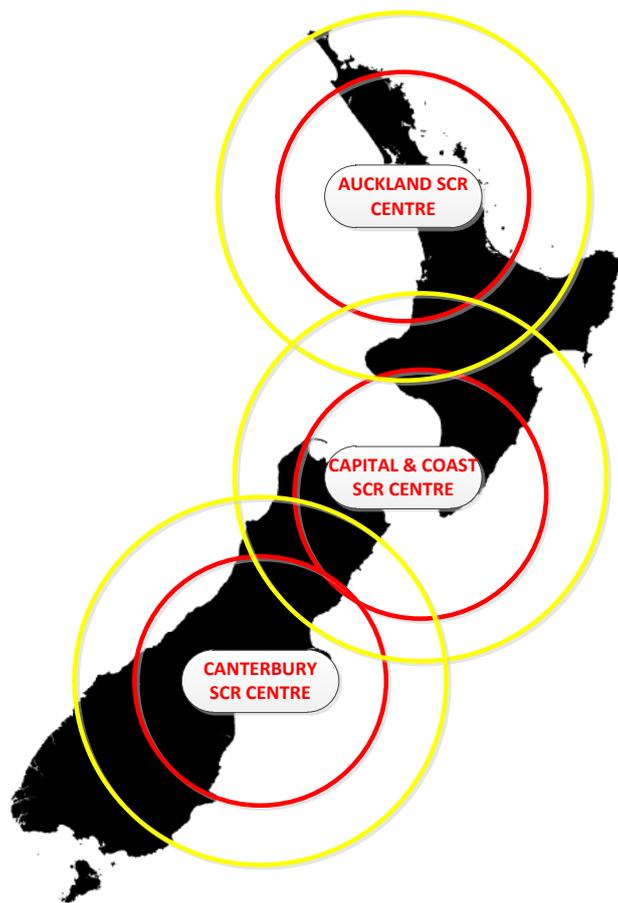
- **Pre-hospital:** ambulance providers, supported by Primary Response in Medical Emergencies providers in rural areas, are usually the first responders to a person who has a stroke. Most patients do not reach hospital until two hours after the onset of stroke symptoms. This may be due to delays in calling an ambulance, physical distance from a hospital or traffic conditions.
- **Stroke centres:** Stroke centres are thrombolysis-equipped hospitals that provide rapid access to brain imaging (CT/CTA/CTP) and IV thrombolysis. This takes around 60 minutes, but may take longer out of hours. Once a potential SCR candidate is identified, CT images have to be electronically transferred for review, and the case discussed with an SCR neurologist to confirm eligibility treatment. It takes 15–30 minutes to arrange and initiate inter-hospital transfer, if SCR is considered appropriate. Transfer arrangements need to take into account weather, road or air conditions and escort requirements.
- **SCR centres:** Staff at the SCR centre that receives the patient need to assess the patient and confirm their suitability for SCR. This, and rapid transfer to the angiography suite, takes 15–30 minutes.
- **Inter-hospital transfer:** If the time-critical requirements of the pre-hospital, stroke centre and SCR centre settings are achieved, a maximum of two hours remains available to transfer patients from the stroke centre to the SCR centre. Inter-hospital transfer may occur by road or air, depending upon the distance between hospitals, the availability of a helicopter and weather conditions. Efforts to minimise transfer times are essential.

2 Requirement for equitable access

The inter-hospital transfer time constraint is relevant in regard to the principle of equitable access to SCR. For large portions of the New Zealand population, travel times to an SCR centre may preclude access, especially if the other time-critical requirements of the pathway cannot be met.

Air transfer is often most appropriate in circumstances where a person is being transferred from a stroke centre distant to the SCR centre. The pathway provides for a maximum flight time of two hours. The East Coast, Fiordland, Southland and Queenstown fall outside this (see the yellow circles in Figure); therefore, people in these areas would have no access to SCR. If the flight time was reduced to only 90 minutes (red circles in Figure) because some other elements of the pathway took longer some larger urban cities, such as Dunedin, New Plymouth, Napier and Hastings, would be precluded from accessing SCR.

Figure 4: Flight times to a stroke clot retrieval centre



Some of the areas that would be precluded from SCR by excessive flight times have a proportionally large Māori population; for example, 50 percent of people living in the Hauora Tairāwhiti region are Māori. Consideration of flight times is therefore important to address equity of access.

When transfer is within a city or DHB region and occurs by road traffic can impact on transfer times; for example, heavy traffic is likely to impact on transfer from Counties Manukau DHB to Auckland City Hospital. Given that 37 percent of people in the Counties Manukau DHB are Māori or Pacific peoples, this, too can contribute to inequity of access.

At the moment, SCR is provided inconsistently across New Zealand, and access is far from equitable. It is almost exclusively provided to people who live in the Auckland metropolitan region, Wellington or Christchurch.

3 Requirement for 24/7 availability

To ensure timely and equitable access to SCR treatment, SCR centres need to offer services 24 hours per day, seven days per week, so that people are not disadvantaged based on the time of day they present, or where they live.

In a 24/7 SCR service, there must be enough suitably skilled and qualified neurointerventionalists, neurologists, stroke nurses, anaesthetists and anaesthetic support staff to maintain at least a one-in-three roster, and preferably a one-in-four roster.

DHBs providing SCR will need to develop local or regional business cases to determine the areas where they require investment to ensure these resources.

The three SCR centres currently operating have identified the following barriers to providing a 24/7 service:

- general issues associated with staff recruitment and retention (especially neuroradiologists)
- increased work load for neurologists in terms of being on-call, patient load and complexity
- increased pressure for radiology services, particularly related to the provision of CTA and CTP
- increased requirements for on-call interventional neuroradiology, and the associated costs.

4 Requirement for highly skilled proceduralists

To ensure the sustainability of the workforce, we need a national, credentialed SCR proceduralist training programme. To accommodate likely patient volumes over the coming years, this programme should train one accredited SCR-capable clinician every two years so that New Zealand will be able to cope with the increasing patient volumes in coming years.

The strategy recommends that a SCR proceduralist needs to do at least 10 cases per year to maintain their clinical expertise. Therefore, if a DHB is to provide a one-in-three roster, they would need to provide about 30 SCR procedures per annum, and ensure appropriate distribution across SCR proceduralist. It is accepted that more than one clinician may attend a procedure, to make attainment of these volumes more feasible.

A more sustainable service would require at least four neurointerventionalists and at least 40 procedures per annum.

A training programme would require an SCR centre with relatively high SCR volumes, to meet training requirements.

Priority areas for improvement

The Action Plan's objectives will be achieved by focusing on the following five priority improvement areas. Each of the five priority areas for improvement outlines what needs to happen to achieve safe, accessible, equitable and sustainable SCR services across New Zealand.



1. Ensure that care is patient-centred, culturally appropriate, high-quality and safe

- Ensure patient-centred and culturally appropriate standards of care are in use in all stroke and SCR centres
- Provide high-quality and safe care
- Establish and implement an audit framework to self-assess performance



2. Reduce transfer delays

- Increase public awareness of the need for urgent stroke care
- Develop and implement destination policies for stroke, including diversion options
- Develop and implement standardised bidirectional inter-hospital transfer pathways/protocols



3. Improve radiology access, capacity and capability

- Undertake modelling and analysis of proposed stroke pathway impacts for radiology
- Develop and implement standardised radiology and CT protocols
- Identify options to reduce image transfer delays



4. Enable implementation of telestroke services

- Ensure that SCR centre neurology/stroke teams work with DHBs to provide telestroke services
- Implement a national approach to quality assurance, audit and peer review of telestroke



5. Enable safe, sustainable SCR services

- Assess interventional service requirements
- Ensure safe staffing levels across the multidisciplinary team is at safe levels
- Increase service availability to 24/7 in all SCR centres
- Ensure that funding of SCR services reflects the true cost of provision

Measures

How we will know the SCR objectives are achieved

Measures to understand and track achievement of the SCR Action Plan's objectives are outlined below.

Objective	Measures/standards
1 Improve access to SCR	<ul style="list-style-type: none"> All designated SCR centres offer 24/7 regional services. All secondary stroke hospitals offer 24/7 CT/CTA and CTP. Transport, SCR and radiology pathways are in place throughout New Zealand. Five percent of people with AIS receive SCR by 30 June 2021.
2 Reduce inequity of access to SCR	<ul style="list-style-type: none"> Five percent of people with AIS who live in provincial centres receive SCR by 30 June 2021. Five percent of Māori with AIS receive SCR by 30 June 2021. Five percent of Pacific peoples with AIS receive SCR by 30 June 2021.
3 Provide patient-centred, culturally appropriate care	<ul style="list-style-type: none"> Patient experience survey is developed, using adapted Health Quality & Safety Commission domains to determine baselines, set targets and assess achievement. This survey includes patient satisfaction and comfort. Transfer back to DHB of domicile occurs within an agreed timeframe. Regular audits occur against agreed process metrics.
4 Improve health outcomes	<ul style="list-style-type: none"> A reduction in mRS scores at around three months post-stroke. A reduction in the number of people requiring inpatient post-stroke rehabilitation. A reduction in hospital length of stay (LOS) after a stroke (LOS is used here as a marker of post-stroke disability). Post-SCR complication rates and seven-day mortality rates are consistent with international benchmarking. Increased 'days alive out of hospital' within 90 days of a stroke.
5 Improve equity in outcomes	<ul style="list-style-type: none"> The proportion of patients requiring long-term rehabilitation is similar between different geographic and ethnic groups. Māori and Pacific LOS after a stroke is comparable to non-Māori/non-Pacific. Māori and Pacific mRS scores at three months after a stroke is comparable to non-Māori/non-Pacific. Seven-day mortality rates following AIS are similar between population sub-groups. Māori and Pacific have comparable 'days alive out of hospital' within 90 days of a stroke.

System enablers

System enablers are activities that will support us in achieving the SCR objectives but which require action at a system level.

In the context of SCR, system enablers are clinical leadership, SCR centre workforce, regional stroke centre workforce, information technology (IT), CT imaging as well as perfusion and thrombolysis pathways. Table 4 sets out how each of these enablers can help achieve the SCR objectives. The remainder of this section looks at each enabler in more detail.

Table 4: System enablers

What	How
Clinical leadership	<p>Clinical leadership over the transformation process supports consistent achievement of the service objectives, in line with the strategy.</p> <p>Planning and performance is oriented to drive improved equity in access and outcomes.</p>
SCR centre workforce	<p>SCR centres have a sufficient workforce across the multi-disciplinary team to support a safe and sustainable 24/7 roster.</p> <p>Proceduralists undertake sufficient procedures to maintain their clinical competency.</p> <p>The workforce provides safe and effective services that support improved outcomes.</p>
Regional stroke centre workforce	<p>The regional stroke centre multi-disciplinary workforce provides timely access to investigations and treatment that enhances the ability of people with AIS to access SCR.</p> <p>Regional stroke centres uses nationally consistent guidelines for patient selection to identify SCR candidates.</p>
IT	<p>Telestroke supports timely clinical decision-making, and facilitates communication between ambulance staff, ED staff, neurologists and neurointerventionalists.</p> <p>Technology supports collection of outcome data by treatment teams, allowing evaluation of the service for quality and effectiveness.</p>
CT imaging and perfusion pathways	<p>Timely access to CT, CTA and CTP, when required, supports people with AIS to have appropriate access to SCR.</p>
Thrombolysis pathways	<p>Effective agreed pathways (either directly or via telestroke) supports achievement of the minimum 10 percent goal for thrombolysis as stated by the strategy. This allows people to access SCR where it is clinically appropriate.</p>

Clinical leadership

The Ministry intends to engage a national clinical director (CD) for SCR for from January 2020. The CD will work with DHBs, regional SCR teams and stroke project teams to support the improvement programme. In addition, it will be important for DHBs to establish regional champions to oversee the implementation of regional SCR networks and local stroke and SCR leadership at each DHB.

Stroke clot retrieval workforce

The workforce at all points of the SCR pathway will be influential in ensuring a safe and sustainable 24/7 service. Most notably, this workforce includes ED, neurology, radiology, anaesthetics, nursing and intensive care unit (ICU) teams, who are all likely to experience resource burden as SCR patient volumes grow.

SCR centre neurology teams are increasingly assisting with IV thrombolysis and SCR case selection in other DHBs, especially out of hours. DHBs will need to consider this in determining resource requirements.

DHBs providing SCR will need to develop a workforce plan, to assess the multidisciplinary team impacts of providing SCR.

SCR centres need to support sufficient clinical time to provide SCR related services (eg, neurologists, radiologists, nurses, radiographers, anaesthetic teams), and to recruit and retain a qualified multidisciplinary team. They need to recruit sufficient neurointerventionalists to maintain at the minimum a one-in-three on call roster, but should aim for a minimum of four neurointerventionalists for the long-term sustainability of the service.

Training and credentialing guidelines that are fit for a New Zealand context, will be required to better understand requirements for safe provision of services, noting that the strategy has recommended a minimum of 10 cases per year for an operator to maintain clinical skills. Training to support an increase in SCR proceduralists and hyperacute stroke unit (HASU) nurses is also considered important to ensure the sustainability of the service.

DHBs should consider options to redistribute resources saved from in the context of aged residential care and long-term rehabilitation into the provision of SCR services.

Regional workforce

For people experiencing AIS to benefit from SCR, and for DHBs to recoup the savings from improved patient outcomes and reduced dependency on aged residential care, stroke pathways in all parts of New Zealand need to operate effectively. Stroke patients need to be urgently transported to a hospital with 24/7 access to CT imaging and an on-call SCR neurologist (either on site or through remote access) to aid with rapid clinical decision-making. There is also a need for on-site stroke lead physicians to champion the service and educate staff.

DHBs need to take into account the clinician time required at non-SCR centres for thrombolysis decision-making which can be time consuming. However, volumes are anticipated to be small.

DHBs need to assess the workforce requirements to support acute stroke pathways, as these are a key enabler for access to SCR, particularly within emergency, anaesthetics, neurology, nursing and radiology teams:

- radiology teams need to offer more comprehensive imaging and pathways for rapid interpretation, including advanced CTP imaging
- radiographers, angiography nursing teams, anaesthetists, and anaesthesia technicians need to be available
- stroke unit nursing teams need to develop and implement the HASU nurse model of care to support the patient journey.

DHBs should explore options to consider flexible use of the workforce; training programmes to up-skill staff, including simulation; and increased use of telehealth for clinical decision-making. They should implement appropriate triage tools, and training for emergency medical staff and intensive care paramedics.

Information technology

Time constraints of stroke treatment means that clinical decision-making is often made remotely to the patient, and is dependent on technology to transfer clinical information to an appropriately skilled clinician to determine treatment options.

DHBs and ambulance providers should adopt required technology to support telestroke pathways and decision-making. Requirements for high-speed transfer of CT images between centres will be determined and options to adopt required technology will be explored.

The Ministry and DHBs will consider methods to allow access to clinical records, including images. This might occur through a national platform, or through extending permissions, so that clinicians in one region can access records from another region's electronic health record.

The three SCR centres are maintaining a database of treated patients, modified from the NSN's national thrombolysis register. Information collected includes time from stroke onset to imaging, alteplase, groin puncture and recanalisation, as well as patient outcomes. The centres will further develop this database to ensure services' needs are met.

Data will enable constant audit of all patients treated; the results will be presented at the annual NSN Thrombolysis Data Quality Meeting. Mechanisms to facilitate single point-of-entry data capture by treatment teams into the SCR database will be developed. Options to extend the data collected to include other elements; for example, three-month mRS score, LOS and use of anaesthesia.

Computed tomography imaging and perfusion pathways

Clinicians routinely use CT and CTA imaging to diagnose AIS and determine a patient's suitability for thrombolysis. CTP imaging is required for patients anticipated to arrive at the SCR centre between six and 24 hours of symptom onset, and with 'wake-up' stroke.³ To ensure that patients who are clinically suitable for SCR are not excluded because of the time constraint, it is essential that imaging occurs very quickly after a patient arrives in an ED.

Pathways that support timely access to CT scan, CTA and CTP are required in centres receiving patients with suspected AIS.

DHBs that have hospitals designated as acute stroke facilities need to consider the resources needed to implement 24/7 access to high-quality CT imaging in line with agreed protocols. As protocols are developed and endorsed, individual DHBs will need to implement those. If new technology is required to support protocols, including transmission, DHBs will need to consider inclusion of this technology within their capital development plans, unless a national solution is developed (eg, bulk purchasing of software programmes or post-imaging processing to occur after raw images are transferred to SCR centre).

Effective agreed pathways (either directly or via telestroke) will support achievement of the minimum 10 percent goal for thrombolysis, and increase the number of people able to access SCR.

Additionally, the development of nationally agreed patient selection criteria for advanced imaging would help with resource optimisation.

Thrombolysis

SCR treatment volumes are inextricably linked to IV alteplase treatment rates. IV thrombolysis treatment is not equitably distributed by DHB region; people treated in large metropolitan DHBs or those that currently have tertiary telestroke support are most likely to receive thrombolysis and therefore be considered for SCR (ECR Working Group 2016).

It is assumed that 33 percent of people who receive IV alteplase will be suitable for SCR. An additional group of people will not be eligible for alteplase but might be eligible for SCR (ECR Working Group 2016).

To ensure access to SCR is equitable, and that Māori, Pacific peoples, and deprived and rural populations experience improved outcomes from AIS, we need to improve access to thrombolysis treatment outside the main centres. The goal is that at least 10 percent of people experiencing AIS receive thrombolysis treatment, and that, where clinically appropriate, they are able to access SCR.

³ 'Wake up' stroke is when an individual has a stroke event while sleeping and displays symptoms upon waking. In this situation the exact time of symptom onset is unknown.

DHBs will need to work with the Ministry and regional shared service agencies to implement telestroke in areas where a 24/7 stroke roster is not maintained. They will need to implement pre- and inter-hospital acute stroke pathways as they are approved and enhance ED staff ability to recognise and respond to AIS.

1: Ensure that care is patient-centred, culturally appropriate, high-quality and safe

Why this is important

Patient-centred, culturally appropriate, high-quality, safe care builds trusting relationships and ensures optimal patient outcomes. Therefore patients and whānau need to be at the centre of care.

When a patient and their whānau experience a stroke this is a sudden, dramatic, life-altering event, which is extremely stressful. The necessary rapidity of assessment, treatment and (in the case of SCR) likely transfer to another centre adds significantly to this stress. While the focus on speedy treatment facilitated by standardised protocols is important, it must not compromise individualised patient care. Clear communication about what is occurring and why, coordination of care, and partnered decision-making are important, to ensure the best possible patient experience.

For most people, but particularly Māori, whānau play an important role in patient wellbeing. To improve equity of access and care, facilitating the presence of whānau through the patient journey is paramount, especially for rural or vulnerable communities who are far from home. Health providers need to understand the barriers that may impact on a patient's willingness or ability to consent to SCR, and minimise them. Such barriers may be cultural, psychological, linguistic, financial or geographical (eg, availability of transport). The most vulnerable people are the most likely to experience these barriers.

Patients often report limited memory of their hyper-acute stroke care. Some patients are entirely unable to make informed choices or give consent for treatment due to the very nature of their stroke. During the period of rapid assessment and treatment, whānau have an important role to play in providing comfort to patients and supporting partnered decision-making. Providers should facilitate whānau presence whenever possible.

Patients who have been transferred to a stroke or SCR centre, and their whānau, have provided universally positive feedback. In general, people understand the concept of clearing a blocked artery, and the time sensitivity for this process. It is generally accepted that it is important to get a stroke patient to the centre with the best possible expertise. As more and more patients bypass their local hospital, or are rapidly transferred to SCR centres, the challenge of assisting whānau to be present becomes greater; this may involve early assistance with travel.

Ensuring and monitoring service quality, speed and resolving any complications is essential, to drive service improvement and optimisation, to achieve the best patient outcomes and equity of access. This requires standardised protocols, triage tools and minimal standards. Subsequent monitoring is best achieved through a standard audit framework comprising centralised data collection, benchmarking, regular reporting and

team-based case reviews. Regional and national meetings that make use of open data sharing provide a good opportunity to share innovation and discuss challenges.

What needs to happen

Patient-centred and culturally appropriate standards of care are in use in all stroke and SCR centres

SCR services must be governed by standards of care that enhance the patient experience, thereby meeting the physical, emotional, social and spiritual needs of the patient and their whānau. An SCR team can demonstrate patient-centred care by:

- listening to the patient and their whānau
- communicating effectively, taking into account physical and cognitive impairments
- respecting patients' preferences, values and beliefs
- partnering with patients and whānau in care and decision-making
- optimising care continuity across providers
- being culturally aware, and acting with consideration and sensitivity
- informing and educating patients and whānau
- ensuring patients' physical comfort
- providing a health care environment that is clean and comfortable
- providing emotional, social and spiritual support
- ensuring equitable access to care.

Understanding patient and whānau needs for patient-centred and culturally appropriate care is critical to ensure increased equity in both access and outcomes. Many factors can influence treatment decisions; the SCR pathway must take these factors into account to ensure the improvement programme does not widen the equity gap for vulnerable populations.

Given the complexity and urgency of the SCR pathway the initial focus of clinicians is likely to be access, communication, coordination across hospitals and services and emotional support, integrated with a patient-focused and culturally appropriate model of care.

For most people, but particularly Māori, whānau have an important role in patient wellbeing. Facilitating the presence and inclusion of whānau in decision-making throughout the patient journey is a priority. Providers need to address the challenges of ensuring partnered decision-making and informed choice, particularly given the difficulties experienced by patients following AIS.

Providers may need to ensure that at least one whānau member is able to travel with the patient to the SCR centre, or assisting with whānau with travel arrangements. The National Travel Assistance (NTA) scheme provides financial support for patients and whānau who have to travel to receive treatment away from home. There are a number of restrictions on who is eligible for this support, and the level of support subsidised. The DHB of domicile is responsible for arranging NTA funding; there is variability among DHBs in terms of how they apply the criteria. Even when travel assistance is approved, access to this support can be slow and inaccessible out of hours.

Travel and accommodation costs or logistics should not be a barrier to a patient accessing appropriate clinical treatment. Improved consistency in access to NTA will be an important element of patient-centred care. Where whānau cannot travel with the patient, DHBs need to develop an alternative way of including them in decision-making.

A range of other mechanisms support whānau in navigating what may be an overwhelming hospital setting, particularly an SCR centre, which is likely to be unfamiliar. Written information, maps, names and contacts are important; DHBs could consider standardising these. In addition, DHBs should develop standardised protocols for repatriation of a patient to their home DHB, and information for patients and whānau.

There may be opportunities for staff to learn from experiences in other hyper-acute areas, such as ST-elevation myocardial infarction (STEMI) and trauma situations.

Provide high-quality and safe care

Hyper-acute stroke interventions are highly effective, but are also associated with potential for adverse outcomes. Standardised pathways for investigations, triaging processes, treatment decisions and transfer to an SCR centre are key to ensuring high-quality and safe care. Minimum SCR service standards are another important component.

A consistently agreed quality assurance programme implemented across all DHBs will ensure patient benefit and ensure safety is maximised.

Establish and implement an audit framework to self-assess performance

The proposed audit framework requires that all relevant providers supply data to a national SCR registry. This allows services to monitor their performance in real time, and provides an opportunity to build and improve the equity evidence base, through ethnicity data reporting. Additionally, DHBs should report on their cultural training approach, and completion rates of cultural competency training. This will help to inform cultural competency best practice across hyper-acute stroke pathways. Regular reports will be distributed to teams for review to benchmark their achievement against other centres. An annual workshop will be held to discuss innovations and challenges, and to ensure continuous improvement work continuously shapes and enhances the services. This workshop will be an extension of the NSN's current annual acute, rehabilitation data and quality days.

Table 5 presents the high-level actions associated with this priority area, alongside activities, lead roles and other roles for each action.

Table 5: Ensure that care is patient-centred, culturally appropriate, high-quality and safe

Activities	Lead	Others involved
Aim: Ensure that patient-centred and culturally appropriate standards of care are in use in all stroke and SCR centres		
<p>Clinical pathways and standards that support patient-centred care:</p> <ul style="list-style-type: none"> consumer groups endorse pathways for standards of patient care. <p>Pathways ensure:</p> <ul style="list-style-type: none"> effective continuity of care along the patient journey that providers address the physical, emotional, social and spiritual needs of patients and whānau timely repatriation to the home DHB. 	<p>CD, National SCR Programme (NSCRP) quality subgroup</p>	<p>NSCRP SCR centre subgroup</p>
<p>Develop resources to inform and educate patients and whānau, and make them available at all points of the SCR pathway:</p> <ul style="list-style-type: none"> consumer groups develop or endorse written patient information that helps patients and whānau understand the hyper-acute stroke pathway before, during and after treatment providers use multiple media approaches (eg, FaceTime) to provide information to patients and whānau, in a number of languages develop information using Rauemi Atawhai principles to support understanding and health literacy which is culturally relevant (Ministry of Health 2012). 		
<p>Promote patient-centred care, among providers, and ensure that:</p> <ul style="list-style-type: none"> educational resources are available they promote cultural competency training a stocktake of cultural competency training and approaches across DHBs, are reported to inform best practice patient experience is monitored and review results with clinical teams periodically. 		
<p>Clinical teams support whānau to participate in effective care partnerships and ensure:</p> <ul style="list-style-type: none"> whānau are connected to advocacy providers or social workers to assist with their needs when they are away from home whānau to access NTA and other resources they are entitled to. 		
Aim: Provide high-quality and safe care		
<p>Minimum service standards for SCR services are developed and providers adheres to them</p>	<p>CD, NSCRP quality subgroup</p>	<p>SCR centres, DHBs, regional networks</p>
<p>Barriers to patients accessing SCR are understood and DHBs put remedial strategies in place to promote equitable access</p>		
<p>SCR volumes are sufficient to support safe practice for interventionalists</p>		
<p>SCR outcome measures are monitored for quality and safety using the established audit framework</p>		<p>Local DHBs, Ministry, NSN, Stroke</p>
<p>All health professionals involved in hyper-acute stroke care are educated in the benefits and requirements of SCR</p>		<p>Foundation (SF)</p>

Activities	Lead	Others involved
Aim: Establish and implement an audit framework to self-assess performance		
<p>Establish a national quality framework for audit and peer review of:</p> <ul style="list-style-type: none"> • service quality and procedural outcomes (eg, NIHSS, mRS, symptomatic intra-cerebral haemorrhage and TIC1 (thrombolysis in cerebral infarction) scores) • timeliness across multiple pathway points (eg, onset to 111, onset to door, door to CT, door to needle, door to groin, door to reperfusion, and door-in-door-out times) • equity of access and outcomes (eg, through monitoring variation based on domicile, socio-economic status and ethnicity) 	CD, NSCRP quality subgroup	SCR centres, DHBs, ambulance services
<p>Establish a morbidity and mortality process to review clinical care and outcomes:</p> <ul style="list-style-type: none"> • ensure feedback loops include referring centres and ambulance providers. 		
<p>Patient experience (including aspects outlined above) through an agreed approach, such as an adaptation of the Health Quality & Safety Commission's Patient Experience Survey that considers aspects of care specific to SCR.</p>		
<p>Measures are reviewed and remedial actions identified and implemented when performance is below expected levels.</p>		



2: Reduce transfer delays

Why this is important

Time is critical in the SCR pathway. Reducing the time taken from a patient experiencing an acute stroke to their arrival in an acute stroke-capable hospital will increase that patient's ability to access SCR treatment, and, ultimately, improve their health outcomes.

Patients presenting to a provincial hospital with stroke face inequity of access to SCR, given the distances between many provincial hospitals and SCR centres. Therefore, the ability to reduce pre-hospital transfer times and inter-hospital transfer times is a priority for the SCR improvement programme.

What needs to happen

Increase public awareness of the need for urgent stroke care

The earlier stroke is recognised and medical assistance sought, the sooner a stroke patient can receive essential treatment.

The national FAST awareness campaign ran until September 2018. The acronym FAST (face, arm, speech, time) aimed to teach the general public about how to recognise signs of stroke, and had a strong focus on reaching Māori and Pacific peoples. Despite this campaign, there continues to be concern about the late presentation of stroke patients. Further work is required to increase public awareness of stroke.

Develop and implement destination pathways to support SCR

St John reports that the average response time from call to on-site arrival of ambulance services for patients with a clinical impression of stroke is 12 minutes across urban, rural and remote areas.

Transfer is usually by road, although helicopter considered if available and able to save at least 30 minutes compared to road transport. Access to helicopter transfers is limited by weather, helicopter availability and increased demand for urgent transfers. Transport decisions are made by the National Air Desk, supported by the dispatcher within the Ambulance Control Centre.

The NSN and the ambulance sector introduced the New Zealand Acute Stroke Destination Policies in 2017. These regional policies:

- confirm the clinical criteria to diagnose acute stroke in the out-of-hospital setting
- confirm the 'cut-off' time for direct transport to a stroke hospital (ie, a hospital capable of performing CT and administering thrombolysis)
- specify the stroke hospitals in each region.

With the introduction of SCR as a treatment option, the ambulance sector, including St John and Wellington Free Ambulance, should review these policies to confirm their relevance.

The Auckland metropolitan area is piloting the pre-hospital acute stroke triage tool (PASTA), which helps ambulance personnel to identify patients with acute stroke with higher specificity, focusing on those who are most likely to benefit from re-perfusion therapy, and especially SCR. As part of the pilot, ambulance personnel liaise with an on-call neurologist for advice on a patient's optimal destination.

A separate Central Region pilot is planned with Wellington Free Ambulance, involving the use of iPads in ambulances to support neurologist-assisted early screening. Results are expected late 2019/early 2020.

Despite the progress being made in developing pathways, the SCR advisory group considers these require further implementation and/or support. It should be noted that referral pathways and DHB borders exist for most established services, although these may differ for neurology, neurosurgery and interventional services. In areas where referral pathways are unclear or do not support timely access to SCR, the affected DHBs should consider formally realigning service borders. Any change to patient flow would require a service change agreement.

Develop and implement standardised bidirectional inter-hospital transfer pathways/protocols

Reducing the time it takes to organise inter-hospital transfers will require coordination across a number of areas.

Early engagement between clinicians and ambulance providers will help reduce the time required. Agreeing protocols for clinical escort requirements may also help. The availability of a medical escort can be limiting; an intensive care paramedic (ICP) or nurse will be appropriate and save time in the majority of cases.

Auckland City Hospital has implemented an online tool to help regional referring clinicians test the suitability of patients for SCR. This is intended to speed up the transfer process, and ensure referrals for patients who are most likely to be eligible. Such standardised triaging tools will support efficient pre- and inter-hospital transfer, and reduce unnecessary treatment delay.

Provision of a telestroke service between provincial centres and stroke-expert physicians in regional SCR centres would potentially facilitate earlier and better patient selection and referral for SCR.

St John is currently working with the clinical directors of ICU retrieval teams to determine the types of time-critical inter-hospital transfers that might be appropriately escorted by a helicopter ICP. It will be important that SCR teams are involved in the development of these protocols. Much may be learned from existing STEMI pathways; and there may be opportunity for regional cross-discipline collaboration.

Inter-hospital stroke transfer guidelines for patients requiring time-critical transfer for SCR have been developed and rapid ICP led transfer pathways are being now in use in the Taranaki, Hutt Valley and Wairarapa DHB areas.

Table 6 presents the high-level actions associated with this priority area, alongside activities, lead roles and other roles for each action.

Table 6: Reduce transfer delays

Activities	Lead	Others involved
Aim: Increase public awareness of the need for urgent stroke care		
The Ministry continues to promote FAST using different forms of media	Ministry, with support from NSCRP (CD)	Health Promotion Agency, SF
The Ministry continues to target promotion towards Māori and Pacific communities		
The Ministry evaluates the effectiveness of the FAST campaign and adjusts its communication approaches based on the results		
Aim: Develop and implement destination policies for stroke, including diversion options		
Review acute stroke destination pathways to ensure they support SCR	CD, NSCRP transfer subgroup	Ambulance providers, SCR centres
Improve the training of ambulance personnel in the recognition and rapid triage of stroke patients, including rural volunteers		
Evaluate the effectiveness of PASTA and the Central Region pilot, and recommends/implements a standardised triage approach		
Identify and introduce pathway champions		Auckland DHB, Ministry
Work with air and road ambulance providers to confirm protocols for determining mode of transport		
Work with the New Zealand Transport Agency to implement recommendations from the 2018 Opus report (OPUS Research 2018) related to rapid transit lanes for ambulance		
Aim: Develop and implement standardised bidirectional inter-hospital transfer pathways/protocols		
Explore the appropriateness of 24/7 telestroke for assessment/selection and early referral of provincial patients for SCR (in ambulances and provincial EDs)	CD, NSCRP transfer subgroup	Ambulance providers, SCR centres
Assess the Auckland SCR tool, and potentially explores implementation in all regions		
Describe clinical requirements for safe and timely transfer, including escort requirements for stroke/SCR		
Review or confirm the protocols being developed by St John and Wellington Free Ambulance		
Evaluate the inter-hospital stroke transfer guideline being trialed, and roll out if appropriate		
Implement local DHB assessment protocols that include clear guidance on how to activate rapid inter-hospital transport		
Develop standardised triaging tools to reduce pre- and inter-hospital transfer delays		



3. Improve radiology access, capacity and capability

Why this is important

Brain imaging of stroke patients with CT is essential to determine suitability for IV thrombolysis. CTA is helpful in thrombolysis treatment. CT plus CTA together are essential when determining suitability for SCR. CTP is helpful in decision-making for both IV thrombolysis and SCR patients, and essential for SCR patients unable to reach an SCR centre within the six-hour time window.

While advanced imaging could be provided at SCR centres upon patient arrival, achieving comprehensive imaging at all stroke centres prior to transfer would minimise inappropriate tertiary centre referrals and transport. Inappropriate transfer is not only wasteful of health resources; it is also unnecessarily burdensome to patients and whānau. For this reason, tertiary SCR teams generally consider that CTA is required *prior* to transfer for all potential SCR candidates, and that CTP is required *prior* to transfer for all patients presenting outside the six-hour window.

People to be considered for IV thrombolysis and/or SCR require brain imaging *immediately* upon arrival at a stroke centre. Currently, 24/7 CT access is reasonable throughout New Zealand, but CTA access is limited, especially out of hours in provincial centres. CTP is largely non-existent, especially outside of the tertiary centres. DHBs need to be able to meet the time-critical imaging requirements for the SCR pathway to be successful. All (and especially more remote) hospitals will stand to gain substantially from a focus on rapid access to both CTA and CTP. Many patients will not be able to reach SCR centres within the six-hour time frame; without access to on-site CTA and CTP these patients will miss out on SCR interventions.

Some of the current access issues relate especially to radiology workforce challenges. The radiology workforce includes medical radiation technologists (MRTs), who perform the scans, and radiologists, who interpret the images. At larger centres, neurologists/ stroke physicians and radiology resident medical officers will usually do the initial read, but radiology senior medical officer reporting is required immediately where these are not available, and eventually in all cases. The private sector is increasingly used to provide formal out-of-hours radiology reporting.

CTP, especially if it is used with advanced software packages such as MIStar® or RAPID, can make acute stroke imaging interpretation faster and easier for neurologists and radiologists. By contrast, CTA image interpretation can be more challenging and time-consuming, especially during the formal reporting stage. Both image sequences add a few minutes to image acquisition, and require IV contrast administration and special MRT skill/experience.

The increased complexity of adding advanced imaging to the current minimum expectation of CT head can result in significant clinical pressures, especially as radiology demand is concurrently increasing in many other clinical areas. This challenge is exacerbated by difficulties in recruiting and retaining radiology staff. We need to make the best use of our available workforce, to ensure sustainable and accessible imaging services for stroke and SCR services.

Once imaging is completed, images need to be made accessible to SCR centre neurologists and neurointerventionists for review. This is ideally achieved through rapid image transfer to the tertiary centre's picture archiving and communication system (PACS) server, or via remote access granted to SCR centre clinicians. Slow transfer times can create significant delays.

Transfer time depends on factors such as process, staffing, infrastructure (including bandwidth), incomplete overlap of regional PACS and stroke networks and hardware issues. Granting SCR clinicians access to other regions' clinical systems to enable remote viewing of scans can be complex or cumbersome, especially if each PACS server requires a separate password and associated update requirements to avoid interim access expiry.

What needs to happen

Undertake modelling and analysis of proposed stroke pathway impacts for radiology

Radiology is a key input into many developing clinical pathways. Most of these pathways put pressure on the service during business hours, but there is also a flow-on impact; staff need to be available for after-hours operation or on-call.

Despite a gradual decline in stroke incidence, raw stroke volumes are expected to increase by 40 percent over the next 10 years, due to population growth and ageing (Ranta 2018).

We need to understand how the changes in acute stroke imaging requirements and anticipated changes in stroke volumes might impact at a local and national level on likely requirements for radiology. Understanding likely demand will inform DHB executive and radiology teams to help develop suitable local radiology models of care for sustainable service delivery.

Develop and implement standardised radiology and CT protocols

Currently, rapid 24/7 access to CTA and CTP is variable. This may be due to an inherent conflict between the perceived resource optimisation of a stepwise approach tailored to individual patients and the potential time savings if image acquisition protocols routinely include CT/CTA and CTP to limit the need for often challenging stepped clinical decision making.

Preventable time delays potentially affect patients' SCR eligibility and ultimately their health outcomes. In addition, limited imaging at regional centres will invariably result in inappropriate transport decisions: some patients who are not eligible will be transported, and some patients who could have benefitted from SCR will not be transported.

To give us the best chance of improving access to SCR, we need to develop standardised radiology hyperacute stroke protocols and pathways, through a cross-disciplinary process. Such protocols will help us ensure that we use available radiology resources and capacity wisely. In addition, nationally consistent patient selection criteria for CTP could help improve clinician confidence in providing CTP in secondary stroke centres.

We may need to establish a consensus ensuring a balance between best practice and achievable solutions. To this end, we should consider alternative models of care for aspects of the radiology pathway. These may include:

- outsourcing routine procedures to allow for increased acute capacity
- conducting impact assessments on resource requirements to meet demand
- ensuring referring hospitals clearly understand the expectations of SCR centres
- formalised use of alternative providers in acute imaging interpretation (eg, neurologists) to allow radiologists to focus on comprehensive sub-acute formal reports and to double reporting acutely only upon request.

To achieve these aims, we will need strong collaboration between EDs, neurology/ stroke teams and radiologists, including interventional neuroradiologists.

Identify options to reduce image transfer delays

Once imaging is completed, images need to be rapidly accessible to tertiary clinicians, to avoid decision and treatment delays.

Solutions to address slow or incomplete image transfer may involve updated PACS systems, higher-speed internet access or a streamlined process for tertiary clinicians to access referring centres' electronic health records. Such solutions may require consultation with IT teams and input from DHBs' chief information officers (CIOs).

Table 7: Improve radiology access, capacity and capability

Activities	Lead	Others involved
Aim: Develop and implement standardised radiology and CT protocols		
Agree on imaging requirements for assessing potential SCR patients, including where, when and which modality	CD, SCR centre leads,	NSN, National Radiology Advisory Group (NRAG), DHB teams, regional stroke and radiology networks, Ministry
Develop sustainable radiology pathways by which stroke patients can access the appropriate level of imaging (CT, CTA, CTP) in the shortest possible time	NSCRП radiology subgroup	
Establish regional groups to localise pathways for implementation		
Consider options to facilitate rapid interpretation of scans as part of the pathway development		
Explore national procurement options for CTP software		
Aim: Undertake modelling and analysis of proposed stroke pathway impacts for radiology		
Undertake modelling of the projected impact of agreed SCR pathways on radiology capacity	CD, NSCRП radiology subgroup	NSN, NRAG, Ministry, regional stroke networks, (potentially) DHB radiology services
Consider different tiers of access or roll-out speed, to provide centres flexibility in implementation		
Agree on and implement workforce/service requirements to provide appropriate access to required imaging		
Aim: Identify options to reduce image transfer delays		
Explore the causes and impact of PACS image transfer delays and related issues	CD, Ministry, DHB CIOs	DHB IT and radiology departments, CIOs
Work with DHB IT teams to seek regional solutions, such as providing access to regional PACS		
Consider options for a national software solution for image transfer, particularly for CT imaging		



4 Enable implementation of telestroke services

Why this is important

IV stroke thrombolysis is a key step prior to accessing SCR for most people. Telestroke is an important enabler to lift both thrombolysis and SCR rates. Currently, IV thrombolysis treatment numbers are not equitably distributed by DHB region. People treated in large metropolitan DHBs are most likely to receive thrombolysis, and therefore most likely to be considered for SCR (ECR Working Group 2016). As previously shown (see Table 3), DHBs with high proportions of Māori or deprived populations have low rates of thrombolysis. Telestroke has been shown to improve inequity (Ranta et al 2017).

Many provincial DHBs are not able to provide 24-hour access to expert stroke physicians. We need to establish telestroke in regions with disadvantaged populations, including Māori, economically deprived or rural populations, to improve equitable access to IV thrombolysis and stroke physicians to facilitate equitable referral for SCR and therefore better health outcomes.

What needs to happen

Ensure that SCR centre neurology/stroke teams work with DHBs to provide telestroke services

In 2016, the NSN projected that, over the next five years, thrombolysis rates would double, from 7 percent to 14 percent (ECR Working Group 2016). In 2018, the thrombolysis rate had improved to 10.8 percent, but access remained inequitable across the country; with provincial centres without telestroke support faring the worst. It is important to ensure that all people who present with a stroke, regardless of location or time of day, have appropriate clinical input into their care to ensure equitable health outcomes.

Larger centres provide 24/7 stroke care through an on-call stroke physician. Where this is not possible, telestroke offers remote access to this expertise. Implementation of telestroke needs to overcome a number of challenges. The service is dependent upon confidence in remote clinical decision-making, the willingness and engagement of tertiary centre stroke physicians, alignment of treatment approaches across all hospitals involved and appropriate technology, including videoconference facilities and remote access to PACS.

To provide continuity of care for people who progress from thrombolysis to SCR, it is most appropriate for telestroke to be provided through a region's tertiary neurology provider or SCR provider. Telestroke services will need to consider whether stroke physicians providing telestroke services need to be available for thrombolysis decision-making 24 hours a day, or only out of hours.

Telestroke is operating well within the Central Region Network (which now includes Taranaki DHB). The Ministry is providing some seed funding to support telestroke pilots in the South Island and in Northland DHB.

The basis for the planned South Island telestroke service will be a regional hub and spoke model: Canterbury DHB will provide stroke expertise to six South Island hospitals (Dunedin, Southland, Dunstan, Oamaru, Timaru and Grey Base). Queenstown's hospital will be included once a CT scanner is in place. In Northland, Whangarei Hospital will provide afterhours telestroke support to other rural Northland hospitals; however, Northland DHB faces challenges with its own out-of-hour rosters, and has identified a need for tertiary support itself, to sustain a 24/7 service. The Midland Region, with the exclusion of Hauora Tairāwhiti, has completed a business case to implement telestroke that is dependent upon recruitment of additional neurologists. Hauora Tairāwhiti is expected to refer SCR patients to Auckland DHB.

These arrangements need to be progressed to ensure a comprehensive national telestroke service available to all hospitals that receive stroke patients and require support.

Implement a national approach to quality assurance, audit and peer review of telestroke

Triage and clinical decision-making are important elements of telestroke and SCR pathways. We need to agree on consistent, accurate pathways and criteria for referring patients for SCR.

For telestroke to be effective, clinicians need to have confidence in telestroke decision-making; we can ensure this through an effective quality assurance programme. This should comprise clear clinical leadership, alongside alignment of acute stroke management protocols/guidelines in all participating hospitals, data collection, audit and peer review.

Table 8 presents the high-level actions associated with this priority area, alongside activities, lead roles and other roles for each action.

Table 8: Enabling implementation of telestroke

Activities	Lead	Others involved
Aim: Ensure that SCR centre neurology/stroke teams work with DHBs to provide telestroke services		
Each region determines the appropriate telestroke model to meet its needs, in terms of the number and location of hubs and spokes	CD, NSCRP telestroke	DHB stroke services, DHB
Agreements are in place with between a 24/7 tertiary neurology service (or, potentially, a secondary stroke service) to provide (at a minimum) after-hours telestroke services to referring DHBs	subgroup regional stroke networks,	radiology and IT services, Ministry, ambulance services, NSN
Explore the need for 24/7 tertiary telestroke services, especially to support rapid and appropriate SCR selection, but also potentially to support daytime thrombolysis decision-making	DHB stroke leads	
Identify lead stroke physicians and nurses to provide clinical leadership on telestroke in each DHB		
Participating telestroke hospitals align, and potentially develop a single acute stroke protocol/guideline that can be modified to account for local factors		
Ensure remote PACS access is provided to telestroke teams		
Ambulance providers are aware of changes in stroke service availability, so their destination pathways can be updated		
Aim: Implement a national approach to quality assurance, audit and peer review of telestroke		
A quality assurance programme is established as part of each regional telestroke model, which includes case review and morbidity and mortality review meetings	CD, NSCRP telestroke subgroup,	Regional stroke networks,
'Spoke' stroke clinicians participate in at least quarterly thrombolysis review	regional stroke networks	DHBs' stroke services, NSN, Stroke Society of Australasia
Data collected and submitted to the to the National Stroke Register, used to capture thrombolysis patients for quality assurance purposes		– New Zealand, Ministry
All stroke thrombolysis calls are logged where these that do not result in treatment, including reasons for this		
All technical failures are logged		
A survey is completed at the end of any telestroke pilots		



5 Enable safe, sustainable SCR services

Why this is important

Equity is an important marker of quality. People should have the same access to SCR services and outcomes following stroke, regardless of who they are and where they live.

To achieve equity in the context of SCR, we need to establish a safe and sustainable 24/7 SCR service that is no more than a two-hour flight away from all regional stroke centres. This will require a sufficient workforce across multidisciplinary teams, and, specifically, a sustainable one-in-four roster that does not have a long-term dependence upon international recruitment.

What needs to happen

Assess interventional service requirements

To ensure a 24/7 SCR service can be provided there needs to be an understanding of the interventional service capacity and any gaps that may impact on the ability to provide this service.

A stocktake of the SCR centres' interventional radiology service capacity in equipment, facility and staffing levels will inform any risks and allow prioritisation of future investment. Where there are capacity constraints that cannot be addressed because there is a lack of suitably skilled staff, or a time lag to recruit to vacant positions, DHBs should be exploring options to increase their capacity. This may involve outsourcing some routine procedures to local private providers.

Gaining feedback on the impact of providing SCR services for staff will help to identify critical service gaps.

SCR centre staffing is safe and sustainable

The SCR workforce is multidisciplinary: it involves nurses, technicians and medical staff from EDs and neurology, anaesthetics and radiology departments. The proceduralist in SCR procedures will be a neurointerventionalist.

A SCR centre should have a minimum of four neurointerventionalists to maintain safe practice volumes and ensure neurointerventionalists treat at least 10 SCR cases annually to maintain clinical skills, as guided by the strategy. This means that an SCR centre needs to be performing at least 20 SCR procedures per year, which limits the number of SCR centres proposed in phase one of the strategy implementation to three, with current patient volumes.

We acknowledge the tension between centralising services to ensure quality and safety and the resulting potential impact on equitable access. This tension may resolve over time as stroke pathways become more streamlined and increasing thrombolysis rates increase the number of potential SCR candidates.

The availability of trained and credentialed neurointerventionalists capable of performing SCR is limited, as HealthPACT noted in the Australian context in its 2015 technology brief (Queensland Department of Health 2015). In New Zealand there are currently 11 clinicians qualified to provide SCR (five in Auckland, one in Waikato, two in Wellington and three in Christchurch).

A New Zealand neurointerventional fellowship training programme would be an important mechanism to ensure an ongoing supply of neurointerventionalists. Without this, DHBs will be dependent upon international recruitment, which comes with high costs and long lead-in times. Some fellowship training currently occurs in Auckland but this requires further support to expand it to the other SCR centres.

Alternative models of care that make use of other interventionalists (eg, cardio-interventionalists) may provide solutions for some aspects of care, but present challenges in terms of quality and credentialing.

We also need to consider staffing requirements for other members of the multi-disciplinary team, including HASU nurses. To ensure the service is sustainable, we need to develop HASU nurse models to support safe and sustainable rostering, recruitment and training, and we need to be able to forecast demand and impacts on the wider multi-disciplinary team.

Increase service availability to 24/7 in all SCR centres

Auckland provides a 24/7 service to Northern and Midland region DHBs. Canterbury currently offers a 24/7 service limited to Canterbury DHB and West Coast DHB patients only, with plans to roll the service out Southern and South Canterbury DHBs in the near future. Capital & Coast DHB offers SCR services from 8 am to 10 pm to Central Region and Nelson Marlborough DHBs seven days a week. There are plans to provide a 24/7 service in the near future.

Because of the limited hours of SCR service availability, people who present to the SCR centre's ED during regular hours are more likely to be considered for SCR. People who live outside the area of an SCR centre, or who present after hours, are less likely to meet eligibility criteria for SCR, because of the time it would take to assess, image and transfer them to an SCR centre.

The Central region has approved a business case to develop capacity to provide a 24/7 SCR service. Recruitment of neurointerventionalists has now been completed and the regional service is being rolled out using a phased approach. The service is currently available seven days a week 8 am to 10 pm with a 24/7 service expected in the near future. Work is currently under way to provide out-of-hour telestroke services 24/7 and upgrade Central region's angiography equipment to support this.

Christchurch Hospital is currently the only provider of SCR in the South Island region. The Canterbury SCR centre's projected volume of patients for the current year (both within and after hours) is 105. This is made up of 60 from Canterbury DHB and 45 from other South Island DHBs. Christchurch has extended its service to the rest of the South Island in July 2019 and in the final stages of implementing a regional telestroke service.

Progressing actions in Priority 2 through improved transfer times between hospitals will be critical to improving access to SCR in all regions.

Ensure that funding for SCR services reflects the true cost of service provision

Funding of SCR services presents a number of challenges. Within New Zealand, inpatient care is funded through DRG weights. The DHB where a patient lives funds the cost of care at an agreed 'price per weight'. The costs of the procedure (averaged) determine the weights and therefore the price.

Because SCR is a relatively new technology, costs for it may be under-reported. In addition, the current cost profile will be driven by the cost of provision of services during standard hours, rather than the higher cost of a 24/7 service. Costs associated with patient investigation and thrombolysis treatment in stroke centres will not be considered as part of the cost profile of treatment.

Interventional radiology costs within an SCR centre will contribute to costs, but there is limited visibility of how these are collected and reflected in the DRG weights.

To ensure the sustainability of SCR services, we need to understand cost profiles and ensure that the IDF funding model adequately recovers the cost of SCR services.

Table 9 presents the high-level actions associated with this priority area, alongside activities, lead roles and other roles for each action.

Table 9: Enable safe, sustainable stroke clot retrieval services

Activities	Lead	Others involved
Aim: Assess interventional service requirements		
Complete a stocktake of current capacity in terms of equipment and staffing levels	CD, NSCRP SCR centre subgroup	SCR DHB radiology and stroke services
DHBs explore options to increase capacity, such as outsourcing of routine interventional procedures		
Annual staff survey on local service implementation and workforce issues. Staff surveys could be repeated annually or biannually		
Aim: Ensure that staffing across the multidisciplinary team is at safe levels		
Develop minimum criteria for a 24/7 SCR centre, in terms of core and support staff	CD, NSCRP SCR centre subgroup	SCR DHB radiology and stroke services, Ministry, New Zealand College of Radiology (RANZCR). DHB simulation laboratories
Complete modelling to forecast SCR activity to inform workforce requirements		
SCR centre business managers work with DHB funders to ensure appropriate resourcing in relevant parts of the pathway		
A workforce plan is developed to consider current and future specialist workforce requirements across the multidisciplinary team		
Training and credentialing guidelines for New Zealand are developed in conjunction with the Royal Australian and RANZCR		
Simulation training is available for interventionalists, to support continued safe practice		
Aim: Increase service availability to 24/7 in all SCR centres		
Capital & Coast and Canterbury DHBs review staffing requirements for SCR centres, to sustain a 24/7 roster and develop recruitment plans	CD, NSCRP SCR centre subgroup, Capital & Coast and Canterbury DHBs	Regional stroke groups
Consider the requirements for stroke nurses to support the patient pathway for a 24/7 service		
Aim: Ensure that funding for SCR services reflects the true cost of provision		
The Ministry recommends that the NCCPP regularly reviews cost inputs into SCR to ensure the SCR DRG includes fully realised costs	CD, Ministry, SCR centre managers	DHBs, relevant Ministry committees
SCR business managers review costing data to ensure fully absorbed costs are being collected and reported		
Review the funding model once pricing/weights are confirmed, to determine whether an alternative funding model is indicated		

Implementation approach

Once the action plan has been endorsed implementation work will formally begin. Implementation will be led by the CD with support from the Ministry of Health.

To support implementation, we also propose the establishment of:

1. a multi-disciplinary national SCR leadership group (the leadership group), with clinical and operational representation from SCR centres, national and regional stroke networks, NRAG, the National Ambulance Sector Office governance group and the Ministry of Health. This group would have governance over implementation of the programme and the leadership subgroup
2. a subgroup of the leadership group that would focus specifically on progressing actions relevant to multi-disciplinary SCR centre hyper-acute stroke teams aiming to promote patient-centred care and quality assurance (priority area 1) and establishing sustainable SCR centres/workforce (priority area 5).

In terms of reducing transfer delays (priority area 2), improving radiology access and capacity (priority area 3) and enabling telestroke (priority area 4), we suggest a collaborative approach. These priority areas require action from all 20 DHBs and from variety of clinical teams, including general radiology teams, and transport providers. A collaborative approach involves learning sessions, at which the focus would be on learning from each other, applying evidence and addressing the gap between the current state and the desired future state. Collaboratives are most effective when many organisations and disciplines are involved. The leadership group would oversee the progress of this approach in meeting Priorities 2, 3 and 4. Additional subgroups may be established to focus on specific actions within these priorities.

Key enablers of implementation will be the appointment of the CD, DHB support for participation in the networks and learning sessions (in terms of both time and travel) and a commitment from regional shared services agencies to continue to include SCR and stroke in their regional priorities.

An action tracker will be developed to assess progress in achieving each of the actions. The leadership group will review this tracker at least biannually.

The CD, with support from the leadership group, will provide clinical leadership and expert advice to regional shared services agencies and DHBs. Over time, this will be increasingly devolved to regional and DHB teams.

Regional shared service agencies have stroke services in their existing priorities and work programmes that already include SCR implementation efforts. The CD will engage with all regional teams to discuss implementation, to ensure national and regional efforts are aligned. Regional shared service agencies will work with DHBs to support SCR actions as part of their existing work programmes, with support from the National SCR Service Improvement Programme and CD.

Regional project teams will focus on ensuring that plans are developed and implemented in relation to the agreed priority areas and system enablers. The NSN will be a key stakeholder in terms of implementation, and NSN members will take part in leadership and working groups where appropriate.

Evaluation

This action plan requires two forms of evaluation: process evaluation and summative evaluation.

Process evaluation

Process evaluation will assess the extent to which the model has been implemented. To this end, the Ministry will develop questions to help us understand how and where SCR is currently available. These will be linked to the identified measures of success, but should include the following questions as a foundation:

1. To what extent has the service model been implemented?
2. Have all components/actions been delivered?
3. Can the service model be fine-tuned to improve efficiency and effectiveness?
4. Are staff, referrers, patients and whānau satisfied with the service?

The timing of the process evaluation will be determined by the implementation plan timeframe, and will allow for adjustment or revision of any components of the model that are not operating effectively. The provisional timeframe for the process evaluation is 2020/21, with a report to be generated by 30 June 2021.

Summative evaluation

The summative evaluation will examine whether the stated outcomes – particularly quality improvements – have been achieved.

The summative evaluation will consider whether, after implementation of this action plan, the SCR service model has:

1. improved access to SCR
2. reduced inequity of access to SCR
3. provided patient-centred, culturally appropriate and high-quality care
4. achieved improved health outcomes
5. improved equity in outcomes for people undergoing SCR.

The planned timing of the summative evaluation is at least two years after the change is fully implemented (during 2022/23), with a final report to be completed by 30 June 2023.

Glossary of abbreviations

AIS	Acute ischaemic stroke
CIO	Chief information officer
CT	Computed tomography
CTA	Computed tomography angiogram
CTP	CT perfusion
DHB	District health board
DRG	Diagnostic related group
ECR	Endovascular clot retrieval (also referred to as stroke clot retrieval (SCR))
ED	Emergency department
FAST	Face arm speech time
HASU	Hyper-acute stroke unit
ICU	Intensive care unit
IDF	Inter-district flow
IT	Information technology
IV	Intravenous
LOS	Length of stay
M1	Middle cerebral artery – first segment
mRS	Modified Rankin Scale
MRT	Medical radiation technologist
NRAG	National Radiology Advisory Group
NSCRP	National SCR Programme
NSN	National Stroke Network
PACS	Picture archiving and communication system
PASTA	Pre-hospital acute stroke triage tool
SCR	Stroke clot retrieval
STEMI	ST-elevation myocardial infarction

Appendices

Appendix 1: Modified Rankin Scale

Possible scores on the modified Rankin Scale are as follows.

0	Normal
1	No significant disability – able to carry out all usual activities, despite some symptoms
2	Slight disability – able to look after own affairs without assistance, but unable to carry out all previous activities
3	Moderate disability – requires some help, but able to walk unassisted
4	Moderately severe disability – unable to attend to own bodily needs without assistance, and unable to walk unassisted
5	Severe disability – requires constant nursing care and attention, bedridden, incontinent
6	Dead

Appendix 2: Post-stroke clot retrieval procedure observations

Recommended post-procedure observations are similar to post-thrombolysis observations, with the addition of arterial access site and limb vascular observations:

- quarter-hourly for two hours
- half-hourly for next four hours
- one-hourly for next four hours
- two-hourly for next 8–12 hours
- four-hourly until reviewed.

Reportable observations

Reportable observations are as follows:

- hypertension 160/100 – consider why this has occurred (eg, raised intracranial pressure?)
- hypotension < 100 systolic
- new tachycardia (> 100 bpm)
- any evidence of bleeding (apart from bruising), including at the arterial access site
- any change in neurological state, including new or increasing weakness or deterioration in conscious state
- allergic reaction
- fever.

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