Stroke clot retrieval

National Service Improvement Programme

Action Plan

This document will be available at nsfl.health.govt.nz/national-services
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The Ministry of Health wishes to thank the Stroke Clot Retrieval Advisory Group for their input into this National Service Improvement Action Plan. The group comprised people from a wide range of disciplines and District Health Boards (DHBs). Their expertise was invaluable.

We also wish to recognise the members of sub-groups who provided additional input into the development of the actions and measures that are an important part of this plan.

Special thanks go to Dr Anna Ranta, the Clinical Director for Stroke Clot Retrieval, who led and coordinated the work.
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 endovascular clot retrieval in acute ischaemic stroke (AIS) patients who require stroke clot retrieval (SCR).

AIS is one form of stroke, and 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. SCR 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).

SCR is recommended as standard of care in international stroke guidelines, and is being provided in New Zealand on an ad hoc basis. The treatment, for those that receive it, 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 post-onset of symptoms.

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, 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.

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)
Case for change

Stroke

Stroke is the reported to be the second most common cause of death worldwide after ischaemic heart disease at 6.24 million deaths globally in 2015, up from 5.41 million deaths in 2000 (World Health Organisation 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 (ICA) occlusion and approximately 30 percent for proximal middle cerebral artery (M1) occlusion (Riedel, et al. 2011). Outcomes for patients are that 60-80 percent will be dead or dependent at 90 days post-stroke, despite therapy (Barber, et al. 2015).

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

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.

Five randomised controlled trials published early in 2015 reported the clear superiority of SCR plus thrombolytic therapy over standard (thrombolytic alone) therapies (Barber, et al. 2015). For every five people treated one more person is able to go home and live independently. For every 2.6 people treated one person is better than they would have been without the treatment (Goyal, Menon, et al. 2016).

For SCR to be considered, stroke pathways need to be well developed in all DHBs/hospitals. There should be defined hyper-acute stroke pathways used by regional ambulance services, rapid access to Computed Tomography (CT) imaging (including CT angiography and ideally CT perfusion), and timely decision-making about commencing IV thrombolysis. A 24-hour acute stroke service will require reliable access to facilities, imaging and specialist resources. Achieving rapid imaging and optimising other pathway steps is anticipated to require some upfront DHB investment to achieve long-term patient and financial benefits.

Regions that do not have the resources to provide 24-hour acute stroke care should be supported through use of telstroke services to aide timely clinical decision-making.
The cost of providing SCR

The estimated cost of SCR in 2017/18, based on the reported costs of the ad hoc service provided in New Zealand to date, is around $46,000 per person treated, excluding service set up costs (see Appendix 1). Over time this may increase as providers transition to an established 24-hour SCR services 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 DHB where the patients live will gain benefits from reduced medical, rehabilitation and long-term residential care costs.

Treatment outcomes

As found in international statistics, 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 stroke accounts for 4 percent of health loss, while for people aged 75 and over it accounts for 7.3 percent of health loss.

While both stroke incidence and mortality are declining, stroke mortality is declining faster than incidence, suggesting a rise in stroke prevalence and disability can be expected over the next 10 years (Ministry of Health 2016(a)).

Improving the management of AIS through improved recognition and clinical pathways aims to reduce the burden of stroke and improve quality of life. 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 strategy for SCR is intended to supplement the stroke pathway work.

There will be improved health outcomes

In early 2015 five landmark studies reported clear superiority of clot retrieval 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 (Queensland Department of Health 2015).

**SCR Studies:**

- MR CLEAN (Berkhemer, et al. 2015)
- ESCAPE (Goyal, et al. 2015)
- EXTEND IA (Campbell, et al. 2015)
- SWIFT PRIME (Saver, et al. 2015)
- REVASCAT (Jovin, et al. 2015)

The five studies showed improved outcomes following clot retrieval compared with standard therapy, using the modified Rankin Scale (mRS). This is a scale of 0-6 with 0 being symptom free and 6 signifying death (see Appendix 2).

The results of the 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% with a one point reduction in mRS score)
- for every five people treated one more person was alive and independent (mRS of 0-2) at 90 days (ie 20% alive and independent at 90 days)
- for every six people treated one less person was left severely disabled (mRS 4-5) and requiring hospital level residential care (17% less disabled).
Health system costs will be reduced

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 the individual’s assets/ability to pay. Residential care is means tested and people with assets above the threshold are required to fund their residential care at the maximum contribution level (which ranges from $974 to $1063 per week in 2017, depending upon DHB region). People whose assets are below the threshold have their residential care subsidised.

The Ministry’s statistics show that around 65 percent of individuals in a residential care have the majority of the cost of their care subsidised by their DHB, contributing 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 showed improvements that can demonstrate the impact of clot retrieval on reducing dependence on rest home care following stroke.

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

<table>
<thead>
<tr>
<th>mRS</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>0-2</th>
<th>3-5</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCR+IV alteplase No. if 50 treated</td>
<td>26%</td>
<td>26%</td>
<td>20%</td>
<td>17%</td>
<td>3%</td>
<td>0</td>
<td>9%</td>
<td>72%</td>
<td>20%</td>
</tr>
<tr>
<td>13</td>
<td>13</td>
<td>10</td>
<td>9</td>
<td>2</td>
<td>0</td>
<td>5</td>
<td>36</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>IV alteplase only No. if 50 treated</td>
<td>17%</td>
<td>11%</td>
<td>11%</td>
<td>11%</td>
<td>17%</td>
<td>11%</td>
<td>20%</td>
<td>39%</td>
<td>33%</td>
</tr>
<tr>
<td>9</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>9</td>
<td>6</td>
<td>10</td>
<td>20</td>
<td>20</td>
<td></td>
</tr>
</tbody>
</table>

The EXTEND-IA trial showed that 72 percent of people treated with thrombolytics and SCR had a mRS score of 0-2 (essentially independent), compared to 39 percent in the control group which received only thrombolytics (Queensland Department of Health 2015). The results from this study have been translated into the Table 1. The identified improvements have been used to estimate the potential DHB savings.

More stroke survivors will be independent

Savings can be achieved through reduced dependence on aged residential care if an extra 33 percent of people treated with SCR are able to live independently or with minimal support (mRS 0-2).

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). Using a national average of $44,000 per person, savings would be $350,000 per annum for eight fewer patients, or $700,000 for 16 fewer patients. These savings don’t take into account savings associated with reduced hospital stay.

Fewer stroke survivors will be severely disabled

For every 50 patients treated with SCR per year, there will be ten fewer people left moderately to severely disabled at 90 days post-stroke (mRS 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 all people with a mRS of 3 will require rest home care (DHB cost averaging $18,000 per person per year), and those with a mRS of 4 or 5 will require hospital level care (DHB cost 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, with savings accruing for each year of rest home care saved.

**People will spend less time in hospital**

While the hospital cost of providing SCR is relatively high, this can be offset by not only the residential care savings reported above, but also the savings associated with a reduced acute hospital length of stay following AIS.

Table 2: EXTEND-IA length of stay

<table>
<thead>
<tr>
<th></th>
<th>Acute Median</th>
<th>Rehabilitation Median</th>
<th>Total Median</th>
<th>Total Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCR+IV alteplase</td>
<td>8 days</td>
<td>14 days</td>
<td>17 days</td>
<td>4 – 43 days</td>
</tr>
<tr>
<td>IV alteplase only</td>
<td>12 days</td>
<td>33 days</td>
<td>75 days</td>
<td>21 – 90 days</td>
</tr>
</tbody>
</table>

The EXTEND-IA study showed that following SCR people spent less time in hospital (Campbell, et al. 2015). Reduced hospital stay will be associated with significant benefits for DHBs in terms of the cost of treating the patient and additional capacity available for other patients.

**Improving equity**

Māori and Pasifika experience stroke at a significantly younger age (mean age of 60 and 62 respectively) compared to New Zealand Europeans (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 Pasifika.

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

Table 3: IV alteplase in DHBs with a high proportion of Māori, Pasifika or Quintile 5 residents

<table>
<thead>
<tr>
<th>DHB</th>
<th>2015 IV alteplase</th>
<th>DHB % of national IV alteplase</th>
<th>DHB % Māori and Pasifika</th>
<th>DHB % Quintile 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tairawhiti</td>
<td>5</td>
<td>1%</td>
<td>53%</td>
<td>48%</td>
</tr>
<tr>
<td>Lakes</td>
<td>1</td>
<td>0%</td>
<td>37%</td>
<td>34%</td>
</tr>
<tr>
<td>Northland</td>
<td>8</td>
<td>2%</td>
<td>35%</td>
<td>38%</td>
</tr>
<tr>
<td>Counties Manukau</td>
<td>10</td>
<td>3%</td>
<td>35%</td>
<td>36%</td>
</tr>
<tr>
<td>Hawke’s Bay</td>
<td>11</td>
<td>3%</td>
<td>30%</td>
<td>28%</td>
</tr>
<tr>
<td>Whanganui</td>
<td>2</td>
<td>1%</td>
<td>29%</td>
<td>37%</td>
</tr>
</tbody>
</table>

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

While there may be many reasons for the low use of IV alteplase, including higher stroke mortality, distance from a major centre or rural population, ensuring Māori and Pasifika have similar access to both thrombolysis and SCR is important to ensure the equity gap in stroke outcomes is not widened.
A recent NSN review of thrombolysis in Māori found that across the country the latest thrombolysis rate was similar for Māori and non-Māori (9.7% Māori and 8.2% 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 and this remains a concern. We currently lack reliable information on Pasifika, but this data is in the process of being collected.
A plan for stroke clot retrieval

People who have acute ischaemic stroke will have the best possible outcome, provided through high quality and equitable services.

Objectives

The plan’s objectives are to:

1. improve access to SCR
2. reduce inequity of access to SCR
3. provide patient centred, culturally appropriate care
4. achieve improved health outcomes
5. improve equity in outcomes for people experiencing AIS.

To achieve these objectives SCR services will need to be:

- nationally consistent
- sustainable and available 24 hours and be supported by an appropriately skilled workforce
- made optimal use of technology to support referral pathways and decision-making

Principles

The principles for provision of SCR services will align with the five themes of the New Zealand Health Strategy. These are for services to be people powered, closer to home, be of value and high performance, work as one team using smart systems.

**Figure 1: Principles for SCR services**
The service model for stroke clot retrieval

The following approach was recommended through the Strategy as offering the best solution to ensure safety, efficacy, cost effectiveness and equity of access standards.

Figure 2: SCR service model

SCR centre roll-out

Phase 1: Two year plan
1. Regional centralisation of 24-hour SCR services within three initial sites:
   a. Auckland DHB - Auckland City Hospital – the expected referring stroke centres will be from the Northern and Midland Region DHBs, excluding Taranaki after mid-2019.
   b. 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.
   c. 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.

Phase 2: Five year plan
1. Establish a regional 24-hour clot retrieval service at Waikato Hospital within five years (based on the assumption that national volumes can support a fourth centre in a few years’ time).
2. Review stroke thrombolysis volumes in Southern DHB in five years to determine if there would be sufficient SCR volume to support a clinically safe 24-hour service in Dunedin Hospital.

Who can receive SCR?

Eligibility for SCR is determined between the stroke physician and the SCR service following review of the patient 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 (mRS 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 CT perfusion imaging (ie small core).
1. **Transferred within treatment timeframes**

Potential candidates need to be transferred to an SCR centre for treatment within the prescribed timeframes. Eligibility is linked to commencement of groin puncture:

- within 6 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 CT perfusion are met

This requires prompt presentation, rapid diagnosis and clinical decision-making to facilitate timely ‘door to treatment’ procedure. This stage of the process 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.

There is a proportion of people who are not eligible for IV alteplase, but who will still benefit from SCR. These people should be considered on a case-by-case basis following discussion with the SCR centre neurologist and neurointerventionalist.

3. **Have had CT imaging to assess inclusion/exclusion criteria**

The 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 6-hour window should be considered for imaging with CTP, which may also be useful in the sub-6-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.

**What is required to achieve SCR objectives?**

In establishing the 2016 Strategy and national requirements for SCR, there are a number of considerations that went into designing the model for New Zealand service provision and which are critical to achieve the SCR objectives.

1. **Time critical requirements.** Studies have shown that SCR is most effective if started (‘groin puncture’) within six hours after symptom onset. However, the sooner a blood vessel can be opened the better the chance of an improved outcome.
2. **Requirement for equitable access.** This means that 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, be staffed to provide a 24-hour on-call roster, and treat at least 30 patients per year.

3. **Requirement for 24 hours per day availability to avoid treatment gaps.** This means that a SCR centre will require at least three neurointerventionalists to maintain a one-in-three on-call roster, but ideally have four neurointerventionalists to allow for leave and a more sustainable service.

4. **Technical challenge requiring highly skilled neurointerventionalists.** In a study using the US National Inpatient Sample, increased clot retrieval case load was associated with reduced mortality after adjustment for baseline clinical status (Adamczyk, 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 for patients**

One of the main constraints impacting on eligibility for SCR is the time critical requirement for treatment within six hours of 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 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 not already in one) including tasking of the appropriate transport, and staffing it
- Travel time from the stroke centre to the SCR centre
- Time taken to complete the final assessment upon arrival in the SCR centre and the availability of the required staff and theatre/angiography suite.

The SCR pathway in Figure 3 considers each of these elements and assigns the estimated reasonably achievable time for each step, resulting in the estimated maximum allowable treatment window. Based on these estimates, for the required six hour treatment window to be achieved travel time can be no more than two hours. 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.

**Pre-hospital** - managed by ambulance providers, supported by Primary Response in Medical Emergencies (PRIME) providers in rural areas. Most patients do not reach hospital until two hours after stroke symptom onset. This may be driven by delays in calling an ambulance, distance from a hospital and traffic conditions.
**Stroke centres** - 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 case discussed with SCR neurologist to confirm 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** receiving the patient need to assess the patient and confirm suitability for SCR. This, and rapid transfer to the angiography suite, takes around 15 to 30 minutes.

**Inter-hospital transfer** - if the time critical requirements for pre-hospital, stroke centre and SCR centres are achieved, there is a maximum of two hours 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 using a ‘load and go’ model.

**2. Requirements for equitable access**

The inter-hospital transfer time constraint is relevant to support equitable access to SCR. For large portions of the New Zealand population and provincial hospitals travel times to an SCR centre may preclude access, especially if other elements of the pathway cannot be optimised.

Air transfer would be considered most appropriate in circumstances where a person is being transferred from a stroke centre distant to the SCR centre. If the maximum flight time is two hours the East Coast, Fiordland, Southland and Queenstown fall outside this (yellow circles in Figure 4) and would have no access to SCR. If the flight time was reduced to only 90 minutes (red circles in Figure 4) some larger urban cities such as Dunedin, New Plymouth, Napier and Hastings would be precluded from accessing SCR.

**Figure 4: Flight times to an SCR centre**

Some of the areas that would be precluded from SCR have a large proportion of their population that is Māori, for example 50 percent of people living in Tairawhiti DHB (East Coast) are Māori.
Even when transfer is within a city or DHB region, traffic can impact on road transfer times, for example transfer from Counties Manukau DHB (where 37% are Māori or Pasifka) to Auckland City Hospital.

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

### 3. Requirements for a 24-hour per day service

To ensure timely and equitable access to SCR treatment, SCR centres need to offer 24-hour services seven days per week (24/7) so that people are not disadvantaged based on the time of day they present, or where they live.

Minimum requirements for a 24-hour SCR service include the availability of suitably skilled/qualified neurointerventionalists, neurologists, stroke nurses, anaesthetists and anaesthetic support staff to maintain at least a one-in-three roster, or preferably a one-in-four roster.

DHBs providing SCR will need to determine the areas where investment is required to ensure the appropriate resources are in place through the development of local or regional business cases.

The three SCR centres 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 on-call, patient load and complexity
- increased pressure for radiology, particularly related to provision of CTA and CTP
- increased on-call and associated costs for interventional neuroradiology

### 4. Technical challenge requiring highly skilled operators

To ensure the sustainability of the workforce, a national SCR proceduralist training programme is required. This should ensure training of 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 has recommended that a SCR operator needs to do at least 10 cases per year to maintain 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 the operators. 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. Introducing a credentialed training programme will require a large centre with relatively high SCR volumes to support training requirements.
Priority areas for improvement

The following priority areas and high level actions have been identified.

1. **Patient-centred, culturally appropriate, high quality, and safe care**
   - Patient-centred and culturally appropriate standards of care are in use in all stroke and SCR centres
   - High quality and safe care is provided
   - An audit framework to self-assess performance is established and implemented

2. **Reduce transfer delays**
   - Increase public awareness of need for urgent stroke care
   - Develop and implement destination policies for stroke, including diversion options
   - Develop and implement standardised inter-hospital transfer pathways/protocols

3. **Improve radiology access, capacity and capability**
   - Develop and implement standardised radiology and CT protocols
   - Undertake modelling and analysis of proposed stroke pathway impacts for radiology
   - Identify options to reduce image transfer delays

4. **Enable implementation of telestroke**
   - SCR centre neurology/stroke teams work with their regional DHBs to enable provision of telestroke services
   - A national approach to quality assurance, audit and peer review of telestroke is implemented

5. **Enable safe, sustainable SCR services**
   - Undertake assessment of interventional service requirements
   - Staffing across the multidisciplinary team is at safe levels
   - Service availability is increased to 24/7 in all SCR centres
   - Funding for the service reflects the true cost of provision
# Measures

## How we will know the SCR objectives are achieved

Measures to understand and track achievement of the objectives are below.

<table>
<thead>
<tr>
<th>Objective</th>
<th>Measures/Standards</th>
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| 1. Improve access to SCR | • All designated SCR centres offer 24/7 regional services  
• All secondary stroke hospitals offer 24/7 CT/CTA and ideally CTP  
• Transport, SCR, and radiology pathways are in place throughout New Zealand  
• 5% of people with ischaemic stroke receive SCR by 30 June 2020 |
| 2. Reduce inequity of access to SCR | • 5% of people with ischaemic stroke who live in provincial centres receive SCR by June 30 2021  
• 5% of Māori with ischaemic stroke receive SCR by June 30 2021  
• 5% of Pasifika with ischaemic stroke receive SCR by June 30 2021 |
| 3. Provide patient centred, culturally appropriate and high quality care | • Patient experience survey using adapted HQSC domains to determine baseline, set target, and assess achievement. This survey will include patient satisfaction and comfort.  
• Completion of regular audit against agreed process metrics |
| 4. Achieve improved health outcomes | • A reduction in the mRS 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) post-stroke (LOS here is used as a marker of post-stroke disability)  
• A post-SCR complication rate and 7-day mortality that is consistent with international benchmarking  
• Increased ‘days alive out of hospital’ within 90 days of stroke |
| 5. Improve equity in outcomes for people undergoing SCR | • Proportion of patients requiring long-term rehabilitation is similar between different geographic and ethnic groups  
• Māori and Pasifika have comparable hospital LOS post-stroke.  
• Māori and Pasifika have comparable mRS at three months post-stroke.  
• 7 day mortality post-ischaemic stroke is similar between population sub-groups.  
• Māori and Pasifika have comparable ‘days alive out of hospital’ within 90 days of stroke |
How system enablers will support SCR

System enablers are activities that can be applied across all areas of the plan or system to support achieving the priorities.

<table>
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<tr>
<th>What</th>
<th>How</th>
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| Clinical leadership                       | • Clinical leadership over the transformation process will be in place to support consistent achievement of the service objectives, in line with the Strategy.  
• Planning and performance will be oriented to drive improved equity in access and outcomes. |
| SCR centre workforce                      | • SCR centres will have sufficient workforce across the multi-disciplinary team to support a safe and sustainable 24/7 roster.  
• Proceduralists will undertake sufficient procedures to maintain clinical competency.  
• Workforce will provide safe and effective services that support improved outcomes. |
| Regional stroke centre workforce           | • Regional stroke centre multi-disciplinary workforce will provide timely access to investigations and treatment that will enhance the ability of people with AIS to access SCR  
• Regional stroke centres will use nationally consistent guidelines for patient selection to identify SCR candidates |
| Information technology                    | • Telehealth technology will support timely clinical decision-making, and will facilitate communication between ambulance, Emergency Department staff, neurologists and neurointerventionalists.  
• Technology will support collection of outcome data by treatment teams, allowing evaluation of the service for quality and effectiveness. |
| CT imaging and perfusion pathways         | • Timely access to CT scan, CT angiography, and to CT perfusion when required, will support people with AIS to have appropriate access to SCR. |
| Thrombolysis pathways                     | • Effective agreed pathways (either directly or via telestroke) will support achievement of the minimum 10% goal for thrombolysis, and will support people having the opportunity to access SCR where clinically appropriate. |

Actions to develop system enablers

For the system enablers to effectively support SCR pathways and objectives, these will need to be strengthened.

Clinical leadership

Leadership to support the SCR service improvement programme is required.

1. The Ministry will engage a clinical director for SCR for 2018/19 to oversee progress to implement the identified improvement priorities.

2. The SCR clinical director will work with DHBs, regional SCR and stroke project teams to support the improvement programme and focus providers on the outcomes to be achieved, specifically an equitable, patient-centred, high quality, 24-hour service.

Broader leadership requirements will be important, so that DHBs adequately resource their teams to support access to SCR, noting the benefits to patients experiencing AIS, and the savings for DHBs in terms of reduced acute, rehabilitation and aged residential care costs.

1. Areas of need considered important are: establishing regional champions to oversee the implementation of regional SCR networks; and local stroke and SCR leadership at each DHB to ensure successful implementation.
2. In SCR centres there is a need to support protected clinical time to provide SCR related services, and to recruit and retain a qualified multi-disciplinary team. To a lesser extent clinician time at non-SCR centres also needs to be considered as SCR assessments take more time than thrombolysis decision-making – however, volumes are anticipated to be small.

3. Training to support an increase in SCR proceduralists is also considered important to ensure the sustainability of the service.

4. Consideration of options to redistribute resources saved from aged residential care and long-term rehabilitation into provision of SCR services.

**SCR centre workforce**

Support for a safe and sustainable SCR centre workforce is required. Workforce in all parts of the SCR pathway will be influential in ensuring a safe and sustainable 24-hour service. Most notably these will include emergency department, neurology, radiology, anaesthetics, nursing and ICU teams.

SCR centre neurology teams are increasingly assisting with IV thrombolysis and SCR case selection in other DHBs, especially out-of-hours which will need to be considered in determining resource requirements, as volumes increase.

1. The three DHBs providing SCR will need to develop a workforce plan to assess the multi-disciplinary team impacts of providing SCR across the pathway will be required.

2. ECR centres will 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.

3. Training and credentialing guidelines that are fit for a New Zealand context will be required to better understand workforce and activity requirements for safe provision, noting that the Strategy has recommended a minimum of 10 cases per year for an operator to maintain clinical skills.

**Other workforce**

For people experiencing AIS to benefit from SCR, and 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. Patients need to be urgently transported to a hospital with 24-hour 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.

1. DHBs will need to assess the workforce requirements to support acute stroke pathways, particularly in emergency and radiology departments:
   - radiology teams need to offer more comprehensive imaging and pathways for rapid interpretation including advanced CT perfusion imaging
   - radiographers, angiography nursing teams, anaesthetists, and anaesthesia technicians need to be available for procedures
   - stroke unit nursing teams will need to change their model of care to be able to assist throughout the patient journey.

2. Options to consider flexible use of workforce, training programmes to upskill staff, including simulation, and increased use of telehealth for clinical decision-making should be explored.

3. Pathways and protocols that are developed to support access to SCR will need to be implemented, with appropriate workforce support to enable this to occur.

**Information technology**

Information technology is an important enabler for telestroke and for SCR pathways. Because of the time constraints for treatment, clinical decision-making is often remote from the patient, and is dependent on technology to ensure clinical information is transferred to an appropriately skilled clinician to determine treatment options.
1. DHBs and ambulance providers will adopt required technology to support telestroke pathways and decision-making.

2. Requirements for high-speed transfer of CT images between centres will be determined and options to adopt required technology will be explored.

3. The Ministry and DHBs will consider opportunities to allow access to clinical records, including images. This might be 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 National Stroke Network's national thrombolysis register. Information collected includes time from stroke onset to imaging, alteplase, groin puncture and recanalisation, as well as patient outcomes. This database will be further developed to ensure the services needs are met.

Data will enable constant audit of all patients treated and the results will be presented at the annual National Stroke Network Thrombolysis Data Quality Meeting.

4. Mechanisms to facilitate single point of entry data capture by treatment teams into the SCR database will be developed.

5. Options to extend the data collected to include efficiency, outcome, and interventions so these can be measured (e.g. 3 month mRS scale, LOS, use of anaesthesia)

**CT imaging and perfusion pathways**

As part of the diagnosis of AIS, and determinant of suitability of thrombolysis CT imaging is used routinely. Pathways that support timely access to CT scan, CTA and CTP are required in centres receiving patients with suspected AIS.

CT and CTA imaging are required to determine if a patient is clinically suitable for SCR. CTP imaging is required for patients anticipated to arrive at the SCR centre between 6 and 24 hours of symptom onset and with 'wake-up' stroke. To ensure patients who are clinically suitable for SCR are not excluded because of the time constraint, it is essential that imaging occurs very quickly after the patient arrives in the emergency department.

1. DHBs that have hospitals designated as acute stroke facilities will need to consider resource requirements to implement 24-hour access to high tech CT imaging in line with agreed protocols.

2. As protocols are developed and endorsed, these will need to be implemented in individual DHBs.

3. If new technology is required to support protocols, including transmission, DHBs will need to consider inclusion of this within capital development plans, unless a national solution is developed (e.g. bulk purchasing of software programmes or post-imaging processing to occur after raw images transferred to SCR centre).

Effective agreed pathways (either directly or via telestroke) will support achievement of the minimum 10 percent goal for thrombolysis, and will support people having the opportunity to access SCR where clinically appropriate.

**Thrombolysis**

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

It is assumed that 33 percent of the IV alteplase population will be suitable for SCR. In addition there is an additional group of people who are not eligible for alteplase but who might be suitable for SCR (ECR Working Group 2016).
To ensure access to SCR is provided equitably, and that Māori, Pasifica, and deprived or rural populations have improved outcomes from AIS it is important that access to thrombolysis treatment is improved outside the main centres. The goal is that at least 10 percent of people experiencing AIS will receive thrombolysis treatment and that where clinically appropriate they are able to access SCR.

1. DHBs will need to work with the Ministry and regional shared service agencies to implement telestroke in areas where a 24-hour stroke roster is not maintained.

2. Pre and inter-hospital acute stroke pathways will need to be implemented as these are approved.

3. Staff working in emergency departments will need to enhance their ability to recognise and respond with priority when a patient with AIS presents.
1. Patient-centred, culturally appropriate, high quality, and safe care

Why this is important

High quality, culturally appropriate, patient-centred safe care are essential requirements to build trusting relationships and ensure optimal patient outcomes.

Patient and whānau needs must be at the centre of care. When a patient and their whānau experience a stroke this sudden dramatic life-altering event 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 (‘Time = Brain’), facilitated by standardized protocols, is important; team members must also ensure patient care is individualised. Clear communication about what is occurring and why, coordination of care, and partnered decision-making is important to ensure the best possible patient experience.

Supporting whānau to be with the patient is particularly important for rural or vulnerable communities if equity of access and care is to be improved. Barriers that may impact on a patient’s willingness or ability to consent to SCR need to be understood and minimised. These barriers may be cultural, psychological, language, financial, or practical/geographical (e.g., availability of transport). The most vulnerable are 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 in both providing comfort to patients and supporting partnered decision-making. These challenges emphasize the importance of whānau presence whenever possible.

Feedback from patients who have been transferred and their whānau has been universally positive. The concept of clearing a blocked artery and the time sensitivity for this is readily understood. Getting to the centre that has the best expertise is also accepted. As more and more patients bypass their local hospital, or are rapidly transferred to SCR centres, the need to assist whānau to be present becomes more significant and may involve early assistance with travel.

In addition to the patient experience, ensuring and monitoring service quality, speed, and complications is essential to drive ongoing service improvement and optimisation, to achieve best patient outcomes and ensure equity of access. Standardised protocols and minimal standards are required. Subsequent monitoring is best achieved through a standard audit framework with centralised data collection, benchmarking, regular reporting, and team-based case reviews. Regional and national meetings with open data sharing are also 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, therefore meeting the physical, emotional, social, and spiritual needs of the patient and their whānau. The SCR team can demonstrate patient-centred care by:

- Listening to the patient and whānau
- Communicating in ways that can be understood, taking into account physical and cognitive impairments
- Respecting patients’ preferences, values, and beliefs
- Partnering with patient and whānau in care and decision-making
- Optimising care continuity and transition across providers
- Being culturally aware, and acting with consideration, and sensitivity
- Informing and educating patients and whānau
- Ensuring the patient’s physical comfort
- Providing a healthcare environment that is clean and comfortable
- Providing emotional, social, and spiritual support
- Ensuring equitable access to care.

Understanding the patient and whānau needs for patient-centred and culturally appropriate care is critical to ensure increased equity in both access and outcomes. There are many factors that can influence treatment decisions, and the SCR pathway must take these 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. These important areas must be integrated with a more comprehensive ‘patient focussed’ and ‘culturally appropriate’ model of care, despite the challenging hyper-acute setting.

For most people, but particularly Māori, whānau have an important role in patient well-being. Facilitating the presence of whānau throughout the patient journey is a priority. This may include ensuring at least one member of the whānau is able to travel with the patient to the SCR centre and assisting other whānau with travel arrangements. If whānau cannot travel with the patient, an alternative way of including them in decision-making needs to be developed.

Addressing challenges around ensuring partnered decision-making and informed choice need to be explored and addressed, particularly given the difficulties experienced by patients following acute stroke. The importance of whānau in this context cannot be understated.

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 around who might be eligible for support and the level of support required. The NTA funding is the responsibility of the DHB where the patient lives, and there is variability in how DHBs apply the criteria. In addition, even when 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, and in assisting whānau with access NTA support will be an important element of patient-centred care.

There are a range of other mechanisms to support whānau in navigating what may be an overwhelming hospital setting, particularly the unfamiliar SCR centre. Written information, maps, names, and contacts are important and could be standardised. In addition, standardised repatriation protocols and information for patients and whānau about this need to be developed.
There may be opportunities to learn from experiences in other hyper-acute areas such as STEMI and trauma situations.

**High quality and safe care**

Hyper-acute stroke interventions are highly effective, but are also associated with potential for adverse outcomes.

Access to standardised pathways to facilitate investigations, treatment decisions and transfer to an SCR centre are key factors in ensuring high quality and safe care. Minimum SCR service requirements are another important component.

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

**An audit framework is in place to self-assess performance**

The proposed audit framework ensures all patient care providers supply data to a national SCR registry. This allows services to monitor their performance in real time. Regular reports will be distributed to teams for review to benchmark against other centres. An annual workshop will be held to discuss any innovations and challenges to ensure improvement work continuously shapes and enhances the services. This workshop will be an extension of the current annual acute, rehabilitation data, and quality days, which have been organised by the National Stroke Network.

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<th>Lead</th>
<th>Others involved</th>
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| Patient-centred and culturally appropriate standards of care are in use in all stroke and SCR centres | Clinical pathways and standards are developed that support patient-centred care:  
  - Pathways for standards of patient care are endorsed by consumer groups  
  - Pathways ensure:  
    - effective continuity of care along the patient journey  
    - that the physical, emotional, social and spiritual needs of patient and whānau are addressed  
    - timely repatriation to the home DHB | CD, NSCR, Quality subgroup | SCR centre subgroup,         |
|                                           | Resources to inform and educate patients and whānau will be developed and be available at all points of the SCR pathway:  
  - Written patient information is developed and endorsed by consumer groups which helps them understand the hyper-acute stroke pathway before, during and after treatment  
  - Multiple media approaches (e.g., facetime) are used to provide information to patients and whānau, including different languages  
  - Information is developed with a health literacy lens | CD, NSCR, Quality subgroup | SCR centre subgroup,         |
|                                           | Patient-centred care is promoted with clinicians including ensuring that:  
  - Educational resources are available  
  - Cultural competency training is promoted  
  - Patient experience is monitored and results are reviewed with clinical teams periodically | CD, NSCR, Quality subgroup | SCR centre subgroup,         |
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| Whānau are supported to participate in effective care partnerships:                                                                                                                                     | - Whānau are connected to advocacy providers or social workers to assist with needs for people away from home  
- Whānau are supported to ensure they are able to access NTA and other resources they are entitled to | CD, Quality subgroup                                                                                                                                                    | SCR Centre, DHBs, Regional networks, local DHBs MoH, NSN, SF |
| High quality and safe care               | Minimum service standards for SCR services are developed and adhered to                                                                                                                                       |                                                                      |                                      |
|                                            | Barriers to patients accessing SCR are understood and remedial strategies put in place by DHBs to promote equitable access and outcomes                                                                                          |                                                                      |                                      |
|                                            | SCR volumes are sufficient to support safe practice for interventionalists                                                                                                                                                 |                                                                      |                                      |
|                                            | SCR outcome measures are monitored for quality and safety using audit framework below                                                                                                                                 |                                                                      |                                      |
|                                            | All health professionals involved in hyper-acute stroke care are educated in the benefits and requirements associated with SCR                                                                                                   |                                                                      |                                      |
| Establish and implement an audit framework to self-assess performance | Establish a national quality framework for audit and peer review of:  
- Service quality and procedural outcomes (eg, NIHSS, mRS, sICH, TICI score)  
- 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, monitoring variation based on domicile, socio-economic status, and ethnicity) | CD, Quality subgroup                                                                                                                                                    | SCR centres, DHBs, ambulance services |
|                                            | Establish a morbidity and mortality (M&M) process to review clinical care and outcomes  
- Ensure feedback loops include referring centres and ambulance providers                                                                                                                                            |                                                                      |                                      |
|                                            | Patient experience (including aspects outlined above) is measured and understood 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                                                                 |                                                                      |                                      |
|                                            | Measures are reviewed and remedial actions identified and implemented when performance is below expected levels                                                                                                                                                  |                                                                      |                                      |
2. Reduce transfer delays

Why this is important

Time is critical in the SCR pathway. Reducing the time taken from someone experiencing an acute stroke to arriving in an acute stroke capable hospital will increase a person’s ability to access SCR treatment, and to optimise health outcomes.

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

What needs to happen

Increase public awareness

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

The national FAST awareness campaign ran until September 2018. There was a strong focus in the campaign to reach Māori and Pacific people. Focus groups prior to campaign provided good guidance as to direction and need.

Information is provided through a number of sources, such as radio stations, social media networks as well as TV using strong locally focussed influences.

Despite the campaign, there continues to be concern about late presentation of people with stroke, and further work is required in this area.

Destination pathways to support SCR

Reducing response times and transfer times is a priority to improve stroke outcomes.

St John reports that the average response time from call to on-site arrival for patients with a clinical impression of stroke is 12 minutes across urban, rural and remote areas. Rural and remote areas face different challenges to urban areas related to both the location of ambulance services and distance from a stroke capable hospital.

Transfer is usually by road, with 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.

New Zealand Acute Stroke Destination Policies have been developed and were introduced in September 2017. These are regional policies that:
- 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 (capable of performing CT and administering thrombolysis if indicated)
- Specify which hospitals are designated as stroke hospitals in each region.

With the introduction of SCR as a treatment option, these policies should be reviewed to confirm the destination and by-pass protocols are still relevant.
The Auckland metropolitan area is piloting the pre-hospital acute stroke triage tool (PASTA). The tool helps ambulance personnel to identify patients with acute stroke with higher specificity focussing on those who are most likely to benefit from re-perfusion therapy, especially SCR. As part of the pilot, ambulance personnel liaise with an on-call neurologist for advice on the optimal destination.

A 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 early to mid 2019.

Despite the progress being made in developing pathways, advice has been received that these require further implementation and/or support.

**Optimising inter-hospital transfer times**

Auckland City Hospital has implemented an on-line tool/app to help regional referring clinicians test the suitability of patients for clot retrieval. This is intended to speed up the transfer process and focus referrals on patients who are most likely to be eligible. Extending this to other regions could be explored.

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

Reducing the time taken to organise transport for inter-hospital transfers, and then to reduce travel time requires good coordination and collaboration across a number of areas and teams.

Early engagement with ambulance providers will help reduce the time required. Agreeing protocols for clinical escort requirements may help reduce transfer times. The availability of a medical escort can be limiting, and an intensive care paramedic or nurse will be appropriate and save time in the majority of cases.

St John is working with the clinical directors of intensive care unit (ICU) retrieval teams to determine the types of time critical inter-hospital transfers that might be appropriately escorted by a helicopter Intensive Care Paramedic (ICPs). 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 an opportunity for regional cross-discipline collaboration.

A draft inter-hospital transfer guideline has been developed for patients requiring time-critical transfer for clot retrieval and a rapid transfer pathway is being trialled in the Taranaki, Hutt Valley, and Wairarapa DHB areas.
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| Increase public awareness of need for urgent stroke care            | Continue to promote FAST (Face Arm Speech Time) using different forms of media beyond 2018  
Continue to target interventions/promotion with iwi and Pasifika communities  
Evaluate the effectiveness of the FAST campaign and adjust communication approaches based on results | Ministry of Health (MoH) with support from NSCRP Clinical Director (CD) | HPA, SF                                |
| Develop and implement destination policies for stroke, including diversion options | Review Acute Stroke Destination Pathways to support SCR  
Improve training of ambulance personnel in recognition and rapid triage of stroke patients, including rural volunteers  
Evaluate the effectiveness of PASTA and the Central Region pilots and recommend/implement a standardised triage tool/approach  
Identify and introduce pathway champions  
Work with air and road ambulance providers to confirm protocols for confirming mode of transport  
Work with NZTA to progress recommendations from the Opus report related to rapid transit lanes for ambulance | CD, NSCRP Transfer Subgroup | Ambulance providers, SCR centres, ADHB, MoH |
| Develop and implement standardised inter-hospital transfer pathways/protocol | Explore appropriateness of 24/7 telstroke for assessment/selection and early referral of provincial patients for SCR (in ambulances and provincial EDs)  
Assess Auckland SCR app and if agreed explore making it available for all regions and implement if feasible/deemed advantageous  
Describe clinical requirements for safe/timely transfer, including escort requirements for stroke/SCR  
Review or confirm the protocols being developed by St John & Wellington Free Ambulance  
Evaluate the inter-hospital Stroke Guideline being trialled and roll out if considered appropriate  
Implement local DHB assessment protocols that include clear guidance on how to activate rapid inter-hospital transport | CD, Transfer subgroup | Ambulance providers and SCR centres |
3. Improve radiology access, capacity and capability

Why this is important

Brain imaging with CT is essential to determine whether someone is suitable for IV thrombolysis. CTA is helpful in thrombolysis treatment. CT plus CTA are essential when determining suitability for SCR. CTP is helpful in decision-making for both IV thrombolysis and SCR patients and essential in SCR patients unable to reach the SCR centre within the 6 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, but is also unnecessarily burdensome to the patient and their whānau. For this reason, the view of tertiary SCR teams is that CTA is required prior to transfer for all potential SCR candidates and CTP is required prior to transfer for all patients presenting outside the 6 hour window.

For people to be considered for IV thrombolysis and/or SCR brain imaging is required immediately upon arrival at a stroke centre as time is of the essence. Currently 24/7 CT head 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 respond to the time critical imaging requirements for the SCR pathway to be successful. All, and especially more remote hospitals, will stand to gain substantially from rapid access to both CTA and CTP. Many of their patients will not be able to reach SCR centres within the 6 hour time frame, and 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 MRTs who perform the scans and radiologists who interpret the images. At larger centres neurologists/stroke physicians and radiology RMOs will usually do the initial read, but radiology SMO 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, especially at smaller hospitals.

CTP, especially if used with advanced software packages such as MIStar® or RAPID, can make acute stroke imaging interpretation faster and easier for the neurologist and radiologist. 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, require IV contrast administration, and special MRT skill/experience.

This increased complexity of adding advanced imaging to the current minimum expectation of CT head can result in significant pressures especially as radiology demand is concurrently increasing in many other clinical areas. This challenge is exacerbated by difficulties recruiting and radiology retaining staff. It will be important to make the best use of the available workforce to ensure sustainable and accessible imaging services for stroke and SCR.
Once imaging is completed the images need to be made accessible to the SCR centre neurologist and neurointerventionist for review. This is ideally achieved through rapid image transfer to the tertiary centre PACS server or via remote access granted to SCR centre clinicians. SCR centre image access is essential to confirm eligibility for treatment. Slow transfer times for some images can create significant delays.

Transfer time depends on factors such as process, staffing, infrastructure including bandwidth, incomplete overlap of regional PACS and stroke networks, hardware issues. Granting remote access to SCR clinicians can be complex/cumbersome especially if each PACS server requires a separate password with associated update requirements to avoid interim access expiry.

**What needs to happen**

**Undertake modelling and analysis of stroke pathway impacts for radiology**

Radiology is a key input into many developing clinical pathways. While most of these pathways put pressure on the service during business hours there is also a flow-on impact, with staff being available for after-hours operation or-call.

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

It is important 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, so that services can develop the necessary capacity and capability to support the SCR pathway.

Understanding likely demand will provide DHB executive and radiology teams with the required information to develop suitable local radiology models of care that ensures the service can be provided in the most sustainable way.

**Develop and implement standardised radiology and CT protocols**

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 the individual patient and the time-savings if image acquisition protocols routinely include CT/CTA and ideally CTP to limit the need for often challenging step-wise clinical decisions.

All preventable time delays may affect SCR eligibility and patient outcomes. In addition, limited imaging at regional centres will invariably result in inappropriate transport decisions with some people being transported that are not eligible and some patient not being transferred who could have benefitted.

The development of agreed standardised radiology hyper-acute stroke protocols and pathways, developed through a cross-disciplinary process, will have the best chance of improving access to SCR for people with stroke. In addition, standardised protocols will help ensure that scarce radiology resources and capacity are used wisely.

Consensus may be required to ensure there is a balance between best practice and achievable solutions. Consideration should be given to 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 are clear on the expectations of SCR centres
- formalised use of alternative providers in acute imaging interpretation (e.g. neurologists) with radiologists focussing on comprehensive sub-acute formal reports and double reporting acutely only upon request.
Strong collaboration between emergency departments, neurology/stroke teams and radiology, including interventional neuroradiology, is needed.

**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.

The reason for the sometimes slow or incomplete image transfer needs to be understood so appropriate solutions can be put in place. Solutions may involve updated PACS systems, accessing higher speed internet or access and implementation of a streamlined process for tertiary clinicians to access referring centres electronic health record. This aspect of the action plan will require consultation with information technology teams and likely DHB CIO level input.

<table>
<thead>
<tr>
<th>Aims</th>
<th>Activities</th>
<th>Lead</th>
<th>Others involved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Develop and implement standardised radiology and CT protocols</td>
<td>Agree on imaging requirements to assess potential SCR patients including where, when, and which modality</td>
<td>CD, SCR Centre Leads, Radiology subgroup</td>
<td>NSN, NRAG, INRs, DHB stroke and radiology teams, regional stroke and radiology networks, MoH</td>
</tr>
<tr>
<td></td>
<td>Develop sustainable radiology pathways for people with stroke to access the appropriate level of imaging (CT, CTA, CTP) in the shortest possible time</td>
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<td></td>
<td>Establish regional groups to localise pathways for implementation</td>
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<tr>
<td></td>
<td>Consider options to facilitate rapid interpretation of scans as part of the pathway development</td>
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<tr>
<td></td>
<td>Explore national procurement options for CTP perfusion software</td>
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<tr>
<td>Undertake modelling and analysis of proposed stroke pathway impacts for radiology</td>
<td>Undertake modelling of the projected impact of above agreed SCR pathways on radiology capacity</td>
<td>CD, Radiology Subgroup</td>
<td>NSN, NRAG, MoH Regional stroke Networks Potentially DHB radiology services</td>
</tr>
<tr>
<td></td>
<td>Consider different tiers of access or roll-out speed to provide centres some flexibility around implementation</td>
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<tr>
<td></td>
<td>Agree workforce/service requirements to provide appropriate access to required imaging and implement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identify options to reduce image transfer delays</td>
<td>Confirm the impact and causes of PACS image transfer delays and other related issues</td>
<td>CD, MoH, potentially include a DHB CIO to lead this effort</td>
<td>DHB IT &amp; radiology departments, CIOs</td>
</tr>
<tr>
<td></td>
<td>Work with DHB IT teams to seek regional solutions, such as providing access to regional PACS</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Consider options for a national software solution transfer images, particularly CT</td>
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</tbody>
</table>
4. Enable implementation of telestroke

Why this is important

Many provincial DHBs are not able to provide 24-hour access to expert stroke physicians. Therefore other ways of providing appropriate clinical input into acute stroke treatment, and assessment for SCR referral is critical to improve outcomes.

IV stroke thrombolysis is a key step prior to accessing SCR for most people. Telestroke is seen as an important enabler to lift both thrombolysis and SCR rates.

Currently IV thrombolysis treatment numbers are not equitably distributed by DHB region, with people treated in large metropolitan DHBs most likely to receive thrombolysis and therefore be considered for SCR (ECR Working Group 2016). As previously identified (Table 3) DHBs with high Māori or deprived populations have low rates of thrombolysis. Telestroke has been shown to improve inequity (Ranta, Lanford, et al. 2017).

To ensure access to SCR is achieved equitably for disadvantaged populations, including Māori, economically deprived or rural populations, it is important that telestroke is established in these regions to improve access to IV thrombolysis and facilitate patient selection/referral for SCR.

What needs to happen

Telestroke services are in place in all stroke centres not able to achieve the minimum 10 percent thrombolysis rate on their own

Ensuring all people who present with a stroke, regardless of location or time of day, have appropriate clinical input into their care will help improve equitable outcomes from stroke, and achieve the goal rate for thrombolysis.

In 2016 the NSN projected a trend toward doubling thrombolysis rates from the, then, rate of seven percent to 14 percent over the next five years (ECR Working Group 2016). In 2018 the thrombolysis rate is 10.8 percent indicating excellent progress against the NSN target, but access remains inequitable across the country with provincial centres without telestroke support faring the worst.

Larger centres provide 24-hour 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 willingness and engagement of tertiary centre stroke physicians, alignment of treatment approaches across all hospitals involved, appropriate technology including videoconference facilities and remote access to PACS. Confidence in remote clinical decision-making is also required.

To provide continuity of care for people who progress from thrombolysis to SCR it is considered most appropriate for telestroke to be provided through the region’s tertiary neurology provider or the SCR provider.

Telestroke is running well in the Central Region. Taranaki DHB has joined the Central Region network. Other regions are at different states of implementation. The Ministry is providing some seed funding to support telestroke pilots in the South Island and in Northland DHB.
The planned South Island telestroke service will be a regional hub and spoke model, with Canterbury DHB providing the stroke expertise to six South Island hospitals (Dunedin, Invercargill, Dunstan, Oamaru, Timaru, Greymouth). Queenstown will be included once a CT scanner in place. The Northland model is for Whangarei base hospital to provide afterhours telestroke support to other rural Northland hospitals, but this DHB faces challenges with its own out-of-hour rosters and has flagged the need for tertiary support itself to sustain a 24/7 service. The Midland Region has completed a business case to implement telestroke which is dependent upon recruitment of additional neurologists.

These arrangements need to be progressed so that there is a comprehensive and cohesive telestroke service available to all hospitals that receive stroke patients and require support. Telestroke services facilitating SCR need to consider if a 24/7 service is required for thrombolysis rather than just out-of-hours.

**There is a national quality assurance programme**

Triage and clinical decision-making are important elements of telestroke and SCR pathways. Ensuring consistency and accuracy will help ensure that people are referred for SCR appropriately in line with agreed pathways and criteria.

For telestroke to be effective there needs to be ongoing confidence in decision-making and an effective quality assurance programme. This should comprise clear clinical leadership and alignment of acute stroke management protocols/guidelines in all participating hospitals, and data collection, audit, and peer review systems to improve quality of care.

<table>
<thead>
<tr>
<th>Aims</th>
<th>Activities</th>
<th>Lead</th>
<th>Others involved</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCR centre neurology/stroke teams to work with their regional DHBs to support introduction of telestroke services</td>
<td>Each region determines the appropriate telestroke model to meet its needs, in terms of number and location of ‘hubs’ and spokes</td>
<td>CD, NSCRP Telestroke subgroup, Regional stroke networks; DHB stroke leads</td>
<td>DHB stroke services, DHB radiology and IT services, MoH, ambulance service, NSN</td>
</tr>
<tr>
<td></td>
<td>Agreements are in place with a 24-hour tertiary neurology service (or potentially suitable a secondary stroke services) to provide at a minimum after hours telestroke</td>
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<tr>
<td></td>
<td>Explore the need for 24/7 tertiary telestroke support especially to support rapid and appropriate SCR selection, but also potentially day-time thrombolysis</td>
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<td></td>
<td>Lead stroke physicians and nurses are identified and in place to provide clinical leadership in each DHB</td>
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<td></td>
<td>Participating telestroke hospitals to align and potentially work toward a single agreed acute stroke protocol/guideline that can be modified to account for local factors</td>
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<tr>
<td></td>
<td>Remote PACS access will be provided to telestroke teams</td>
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<td></td>
<td>Ambulance providers are aware of changes in stroke service availability so their destination pathways can be updated</td>
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<tr>
<td><strong>Aims</strong></td>
<td><strong>Activities</strong></td>
<td><strong>Lead</strong></td>
<td><strong>Others involved</strong></td>
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<tr>
<td>A national approach to quality assurance, audit and peer review of telestroke is introduced</td>
<td>A quality assurance programme is established as part of each regional telestroke model, which includes case review and morbidity and mortality review meetings</td>
<td>CD, Telestroke subgroup, Regional groups</td>
<td>Regional stroke networks, DHBs stroke services, NSN, SSA-NZ, MoH</td>
</tr>
<tr>
<td></td>
<td>‘Spoke’ stroke clinicians participate in at least quarterly thrombolysis review</td>
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<tr>
<td></td>
<td>Data is collected and submitted to the National Thrombolysis Register</td>
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<tr>
<td></td>
<td>All stroke thrombolysis calls are logged where these do not result in treatment, including reasons</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>All technical failures are logged</td>
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<tr>
<td></td>
<td>A survey is completed at the end of any pilots</td>
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</tbody>
</table>
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.

Achieving equity will be dependent upon the availability of a safe and sustainable 24/7 SCR service that is no more than a two hour flight from regional stroke centres. A 24/7 SCR service requires sufficient workforce across the multidisciplinary team to allow for a sustainable one-in-four roster that does not have a long term dependence upon international recruitment.

What needs to happen
SCR centre staffing is safe and sustainable
The SCR workforce is a multidisciplinary one, which involves nursing, technicians and medical staff from ED, neurology, anaesthetics and radiology. The operator in SCR procedures will be a neurointerventionalist.

The Strategy has identified that neurointerventionalists should be an operator in at least 10 cases per year to maintain safe clinical skills. The service should also have a minimum of four neurointerventionalists for the long-term sustainability of the service to maintain a one-in-four roster. To maintain safe practice volumes a centre needs to be performing at least 40 SCRs per year. This has limited the number of SCR centres proposed in phase 1 of the Strategy implementation to three centres.

The tension between centralising services to ensure quality/safety and the impact this may have for some regions in terms of equitable access has been recognised. It is hoped that this will resolve over time as stroke pathways become more streamlined, and thrombolysis rates increase the number of potential SCR candidates.

The availability of trained and credentialed neurointerventionalists capable of performing the procedure is limited, as noted by HealthPACT in its technology brief (Queensland Department of Health 2015). New Zealand currently has 11 individuals who qualified to provide SCR (five in Auckland, one in Waikato, two in Wellington and three in Christchurch).

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

Alternative models of care which consider how to utilise other interventionalists workforce may provide solutions for aspects of care, but will present challenges in terms of quality and credentialing.

Staffing requirements for other important members of the team also need to be considered, but generally there will be greater opportunity to recruit into these roles. Forecasting demand and impact on the wider multi-disciplinary team will be required to ensure the service is sustainable.
**Service availability is increased to 24/7 in all SCR centres**

Auckland is the only SCR centre that currently provides a 24/7 service. Capital & Coast and Canterbury DHB provided a more limited service. Canterbury offers a service on three out of four nights, which is limited to Canterbury and West Coast DHB patients only. Capital & Coast DHB offers a working hours only service to residents of Capital & Coast, Hutt Valley and Wairarapa DHBs with plans to extend to the wider Central region later in 2018, and to provide a 24/7 service commencing in 2019.

Because of the limited hours of service people receiving SCR in these centres will present to their local ED. People who live outside the area, or who present after hours, are unlikely to meet eligibility criteria for SCR, because of the time taken to assess, image and transfer to the SCR centre.

The Central Region has approved a business case to develop capacity to provide a 24/7 SCR service, which includes recruitment of additional neurointerventionalists. The Central Region’s expectation is that a third specialist will be in place early 2019, allowing them to expand their service hours of operation. Work is underway to upgrade facilities to support SCR with these due for completion by March 2019. A regional plan for implementing SCR across the Central Region is being developed through CentralTAS with a view to a fully regional service operational by mid-2019.

Canterbury DHB at Christchurch Hospital is currently the only provider of SCR in the South Island region, although this may change in future. 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.

**Funding for SCR services reflects the true cost of service provision**

Funding of SCR services has a number of challenges. Within New Zealand inpatient care is funded through Diagnostic Related Group (DRG) weights. The DHB where the 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.

As a relatively new technology costs are likely to be under-reported. In addition the current cost profile will be driven by the provision of services during standard hours rather than the higher costs of providing 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 the SCR centre will contribute to costs but there is only limited visibility of how these are collected and reflected in the DRG weights.

Understanding cost profiles and ensuring the IDF funding model adequately recovers the cost of the service will be important in ensuring the sustainability of SCR services.
<table>
<thead>
<tr>
<th><strong>Aims</strong></th>
<th><strong>Activities</strong></th>
<th><strong>Lead</strong></th>
<th><strong>Others involved</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Undertake assessment of interventional service requirements</td>
<td>Complete a stocktake of current capacity equipment and staffing levels</td>
<td>CD, NSCRP SCR Centre subgroup</td>
<td>SCR DHB radiology and stroke services</td>
</tr>
<tr>
<td></td>
<td>Explore options to increase capacity, such as outsourcing of routine interventional procedures</td>
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</tr>
<tr>
<td>Staffing across the multidisciplinary team is at safe levels</td>
<td>Develop minimum criteria for a 24/7 SCR centre in terms of core and support staff</td>
<td>CD, NSCRP SCR Centre subgroup</td>
<td>SCR DHB radiology and stroke services, MoH, Colleges, DHB simulation labs</td>
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<tr>
<td></td>
<td>Complete modelling to forecast SCR activity to inform workforce requirements</td>
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<tr>
<td></td>
<td>SCR centre business managers work with their DHB funder to ensure appropriate resourcing in relevant parts of the pathway</td>
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<tr>
<td></td>
<td>A workforce plan is developed to consider current and future specialist workforce requirements across the MDT</td>
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<td></td>
<td>Training and credentialing guidelines for New Zealand are developed in conjunction with the College</td>
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<tr>
<td></td>
<td>Simulation training is available for interventionalists to support continued safe practice</td>
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<tr>
<td>Service availability is increased to 24/7 in all SCR centres</td>
<td>Capital &amp; Coast and Canterbury DHBs review staffing requirements to sustain an 24/7 roster and develop recruitment plans</td>
<td>CD, SCR centre subgroup, CC &amp; CDHB SCR DHBs</td>
<td>Regional Stroke Groups</td>
</tr>
<tr>
<td></td>
<td>Consider the requirements for stroke nurses to support the patient pathway for a 24/7 service</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Funding for the service reflects the true cost of provision</td>
<td>Include SCR in the National Pricing Programme work plan for 2019 to ensure fully realised costs understood</td>
<td>CD, MoH, SCR DHB business managers</td>
<td>DHBs, relevant MoH committees</td>
</tr>
<tr>
<td></td>
<td>SCR business managers review costing data to ensure fully absorbed costs are being collected and reported</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Review funding model once pricing / weights are confirmed to determine if an alternative funding model is indicated</td>
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</table>
Implementation approach

Once the action plan has been endorsed implementation work will formally begin. The programme will be divided in the five priority areas and work will be led by the Clinical Director with support from five corresponding priority area subgroups:

1. Transfer
2. Radiology
3. Telestroke
4. SCR Centre
5. Quality.

The Clinical Director, with support from the project team and subgroups, 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 (Northern Region Alliance, Midland Healthshare, CentralTas and South Island Alliance) 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 ongoing implementation work to ensure national and regional efforts are aligned and complementary.

Regional shared service agencies will work with DHBs to support SCR actions as part of their existing work programmes and 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 system enablers and improvement priorities.

Evaluation

Two forms of evaluation are required.

Process evaluation

The first is a process evaluation, which will assess the extent to which the model has been implemented. Questions to help understand how and where SCR is available to improve patient outcomes and equity will be developed. These will be linked to the identified measures of success, but should include:

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 provide an opportunity to adjust or revise any components of the model that are not considered to be operating effectively. The provisional timeframe for the process evaluation is during 2020/21.

Summative evaluation

Following implementation, a summative evaluation will be completed, to see if the stated outcomes, particularly quality improvements, have been achieved.

The Outcomes that will be considered are whether 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 will be at least two years after the change is fully implemented (during 2022/23).
## Glossary and abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIS</td>
<td>Acute ischaemic stroke</td>
</tr>
<tr>
<td>CCINR</td>
<td>Conjoint Committee for Recognition of Training in Interventional Neuroradiology</td>
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<tr>
<td>CI</td>
<td>Confidence interval</td>
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<tr>
<td>CIO</td>
<td>Chief information officer</td>
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<tr>
<td>cOR</td>
<td>Crude odds ratio</td>
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<tr>
<td>CT</td>
<td>Computed tomography</td>
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<tr>
<td>CTA</td>
<td>Computed tomography angiogram</td>
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<td>CTP</td>
<td>CT perfusion imaging</td>
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<tr>
<td>DHB</td>
<td>District health board</td>
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<tr>
<td>DRG</td>
<td>Diagnostic related group</td>
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<tr>
<td>ECR</td>
<td>Endovascular Cot Retrieval (also referred to as Stroke Clot Retrieval (SCR))</td>
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<tr>
<td>ED</td>
<td>Emergency Department</td>
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<tr>
<td>FAST</td>
<td>Face Arm Speech Time</td>
</tr>
<tr>
<td>ICU</td>
<td>Intensive Care Unit</td>
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<tr>
<td>ICA</td>
<td>Internal carotid artery</td>
</tr>
<tr>
<td>IDF</td>
<td>Inter district flow</td>
</tr>
<tr>
<td>INR</td>
<td>Interventional Neuroradiology</td>
</tr>
<tr>
<td>IV</td>
<td>Intravenous</td>
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<tr>
<td>M1</td>
<td>Middle Cerebral Artery – first segment</td>
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<tr>
<td>mRS</td>
<td>Modified Rankin Scale</td>
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<tr>
<td>MRT</td>
<td>Medical Radiation Technologist</td>
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<tr>
<td>NHI</td>
<td>National Health Index</td>
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<tr>
<td>NIHSS</td>
<td>National Institute of Health stroke scale</td>
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<tr>
<td>NMDS</td>
<td>National Minimum Data Set</td>
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<td>NRAG</td>
<td>National Radiology Advisory Group</td>
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<td>NSCRP</td>
<td>National SCR Programme</td>
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<td>NSN</td>
<td>National Stroke Network</td>
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<td>NZTA</td>
<td>New Zealand Transport Agency</td>
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<tr>
<td>p</td>
<td>Probability</td>
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<tr>
<td>PACS</td>
<td>Picture Archiving and Communication System</td>
</tr>
<tr>
<td>PASTA</td>
<td>Pre-hospital acute stroke triage tool</td>
</tr>
<tr>
<td>PRIME</td>
<td>Primary Response in Medical Emergencies</td>
</tr>
<tr>
<td>RMO</td>
<td>Resident medical officer</td>
</tr>
<tr>
<td>SCR</td>
<td>Stroke clot retrieval</td>
</tr>
<tr>
<td>sICH</td>
<td>Symptomatic intra-cerebral haemorrhage</td>
</tr>
<tr>
<td>SMO</td>
<td>Senior medical officer</td>
</tr>
<tr>
<td>STEMI</td>
<td>ST-Elevation Myocardial Infarction</td>
</tr>
<tr>
<td>TICI</td>
<td>Thrombolysis in cerebral infarction</td>
</tr>
</tbody>
</table>
Appendices

Appendix 1 – SCR and stroke cost weights

SCR weights

The following table shows the DRG, weights and co-payment weights, including the average additional weights per day if a ‘high outlier’, for SCR from 2017/18. The majority of SCR admissions would be expected to fall into B02B ‘Cranial Procs W/O Cerebral Haem W Cat CC or (W Cerebral Haem W Sev CC)’.

Table 4: Inpatient weights for SCR 2017/18

<table>
<thead>
<tr>
<th>DRG</th>
<th>DRG Description</th>
<th>Medium inlier weight</th>
<th>Co-payment</th>
<th>Average weight</th>
<th>Average SCR unit value</th>
<th>High outlier weights</th>
<th>Average additional per day if a high outlier</th>
</tr>
</thead>
<tbody>
<tr>
<td>B02A</td>
<td>Cranial Procs W Cerebral Haemorrhage W Cat CC</td>
<td>8.52</td>
<td>4.52</td>
<td>13.04</td>
<td>$61,940</td>
<td>0.35</td>
<td>$1,663</td>
</tr>
<tr>
<td>B02B</td>
<td>Cranial Procs W/O Cerebral Haem W Cat CC or (W Cerebral Haem W Sev CC)</td>
<td>6.40</td>
<td>3.36</td>
<td>9.76</td>
<td>$46,360</td>
<td>0.28</td>
<td>$1,330</td>
</tr>
<tr>
<td>B02C</td>
<td>Cranial Procs W/O Cerebral Haem W Sev CC or W/O Cat/Sev CC</td>
<td>3.95</td>
<td>3.96</td>
<td>7.91</td>
<td>$37,573</td>
<td>0.25</td>
<td>$1,188</td>
</tr>
</tbody>
</table>

Stroke weights

In New Zealand a person recovering from a stroke will have an acute hospital admission that averages between 5 and 9 days at an average cost of $6,000 to $10,000 (NCCPP - Casemix-Cost Weights Project Group 2017). The estimated average length of stay in rehabilitation is 33 days (ECR Working Group 2016).

The table below shows the average length of stay, weight and IDF price for the four stroke diagnostic related groups (DRGs). As this shows the majority of stroke patients spend a relatively short time in acute care, with the bulk of hospital care being in rehabilitation.

Table 5: Acute admission average weights and costs

<table>
<thead>
<tr>
<th>DRG</th>
<th>DRG Description</th>
<th>Average length of stay</th>
<th>Medium inlier weight</th>
<th>Average acute stroke admission value</th>
<th>High outlier weights</th>
<th>Average additional per day if a high outlier</th>
</tr>
</thead>
<tbody>
<tr>
<td>B70A</td>
<td>Stroke &amp; Other Cerebrovascular Disorders W Catastrophic CC</td>
<td>9.31</td>
<td>2.20</td>
<td>$10,467</td>
<td>0.19</td>
<td>$899</td>
</tr>
<tr>
<td>B70B</td>
<td>Stroke &amp; Other Cerebrovascular Disorders W Severe CC</td>
<td>5.12</td>
<td>1.33</td>
<td>$6,295</td>
<td>0.21</td>
<td>$984</td>
</tr>
<tr>
<td>B70C</td>
<td>Stroke &amp; Other Cerebrovascular Disorders W/O Catastrophic or Severe CC</td>
<td>3.52</td>
<td>0.96</td>
<td>$4,563</td>
<td>0.22</td>
<td>$1,038</td>
</tr>
<tr>
<td>B70D</td>
<td>Stroke &amp; Other Cerebrovascular Disorders, Died/Trans Acute Facility &lt;5 Days</td>
<td>1.80</td>
<td>0.67</td>
<td>$3,160</td>
<td>0.25</td>
<td>$1,170</td>
</tr>
</tbody>
</table>
## Appendix 2 – Modified Rankin Scale

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Normal</td>
</tr>
<tr>
<td>1</td>
<td>No significant disability – able to carry out all usual activities, despite some symptoms.</td>
</tr>
<tr>
<td>2</td>
<td>Slight disability - able to look after own affairs without assistance, but unable to carry out all previous activities</td>
</tr>
<tr>
<td>3</td>
<td>Moderate disability - requires some help, but able to walk unassisted.</td>
</tr>
<tr>
<td>4</td>
<td>Moderately severe disability - unable to attend to own bodily needs without assistance, and unable to walk unassisted.</td>
</tr>
<tr>
<td>5</td>
<td>Severe disability - requires constant nursing care and attention, bedridden, incontinent</td>
</tr>
<tr>
<td>6</td>
<td>Dead</td>
</tr>
</tbody>
</table>
Appendix 3 – Post-SCR 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
Hypertension 160/100 – consider why this has occurred (e.g. 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.
References


