National STEMI report
Te pūrongo STEMI ā-motu

Aotearoa New Zealand 2021/22

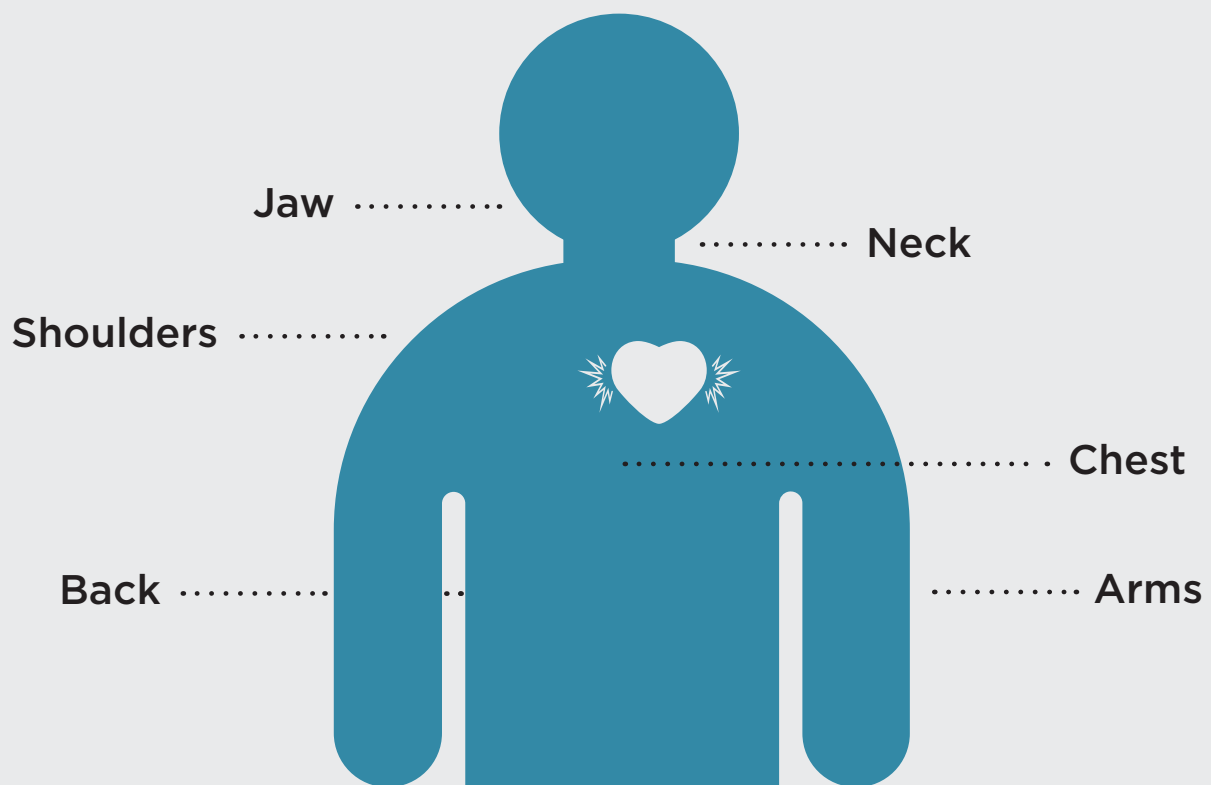# Heart attack warning signs

Pain, discomfort, pressure, tightness or heaviness in any of these areas:

Jaw

Neck

Shoulders

Chest

Back

Arms

You may also feel:

Dizzy

Tired

Short of breath

Sweaty

Sick

If you have any of these symptoms for more than 10 minutes, you may be having a heart attack.
Call 111 and ask for an ambulance.

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Contents

List of figures

List of tables

Introduction
Whakatakinga

Ischaemic heart disease (IHD) in Aotearoa New Zealand carries a large burden of disease.

In 2019 IHD was the second leading cause of death for all New Zealanders, with 47 deaths per 100,000 population. The risk of death from IHD is considerably higher for Māori, who have a rate of 84.8 deaths per 100,000 population [1].

ST-segment Elevation Myocardial Infarction (STEMI) is the most life-threatening manifestation of IHD and requires urgent revascularisation. Revascularisation is achieved with either intravenous fibrinolysis and/or percutaneous coronary intervention (PCI). Intravenous fibrinolysis can be performed by paramedics in an out-of-hospital setting, whereas PCI must be performed in a PCI-capable hospital (Table 1).

NZ PCI-capable hospitals

- North Shore Hospital (restricted times)
- Auckland City Hospital
- Middlemore Hospital (restricted times)
- Waikato Hospital
- Tauranga Hospital (restricted times)
- Wellington Hospital
- Nelson Hospital (restricted times)
- Christchurch Hospital
- Dunedin Hospital

Table 1: List of PCI-capable hospitals. Unless stated, PCI is available 24/7.

Overview of the New Zealand Out-of-Hospital STEMI Pathway

Te tirohanga whānui o te ara STEMI whakaora tara ā-whare Aotearoa

The New Zealand Out-of-Hospital STEMI Pathway (STEMI pathway) aims to shorten the time to reperfusion therapy for patients experiencing out-of-hospital STEMI, Figure 1.

The STEMI pathway guides paramedics' decision making between the two reperfusion strategies (fibrinolysis and PCI). If the patient can be transported to a PCI-capable hospital within 90 minutes of a STEMI diagnosis being made, then the Primary PCI reperfusion strategy is followed. If transport is expected to take longer than 90 minutes, fibrinolytic therapy is the reperfusion strategy followed.

In New Zealand, paramedics can autonomously administer fibrinolytic therapy when STEMI criteria is met and the patient has no clinical contraindications. If relative contraindications are present or the STEMI diagnosis is unclear, consultation with an on-call doctor is required. Following out-of-hospital fibrinolysis, patients are transported to a hospital capable of providing rescue PCI.

Out-of-Hospital STEMI pathway flowchart

Notify the dispatcher of "code STEMI" if air transport is being considered[1]

Transmit 12-lead ECG

Complete fibrinolytic therapy/PCI checklist

Yes ← Can transport to a hospital with facilities for immediate PCI clearly occur within 90 minutes of the diagnosis of STEMI being made? → **No**

Primary PCI

Commence transport to designated hospital ASAP

Fibrinolytic therapy

Administer fibrinolytic therapy ASAP if all of the answers to the fibrinolytic therapy/PCI checklist questions are "no"[2]

Commence transport to a hospital with facilities for immediate PCI ASAP

Notify receiving hospital by radio ASAP

Notify receiving hospital by radio ASAP

Notes
[1] The dispatcher will notify personnel on the Air Desk, who will then phone ambulance personnel at the scene and advise of helicopter availability and estimated flight time to the designated hospital.
[2] Personnel must seek clinical advice prior to administering fibrinolytic therapy if any of the answers to the checklist questions are "yes" or "uncertain".

Figure 1. Out-of-Hospital STEMI pathway flowchart

About this report
Mō tēnei pūrongorongo

This is New Zealand's second annual National Out-of-Hospital ST-Elevation Myocardial Infarction (STEMI) report.

The data presented in this report is for all STEMI incidents attended by the St John and Wellington Free Ambulance services in the period from 1 July 2021 to 30 June 2022.

Data was retrieved retrospectively from ambulance electronic Patient Report Forms (ePRFs). Case selection required both a diagnostic 12-lead ECG and a selected clinical impression (Table 2).

Cases which progressed to cardiac arrest were excluded from analysis. Cases were excluded, where possible, if fibrinolysis was administered by a non-EAS provider.

Where a patient was transported to a hospital that had PCI capability only during restricted hours, we have assumed that PCI was available at the time of transport.

In this report, patients were allocated to the primary PCI reperfusion strategy if they were transported to a PCI capable hospital and prehospital fibrinolysis did not occur.

While New Zealand was fortunate enough to see few COVID-19 cases early throughout the pandemic, the arrival of the Delta variant towards the end of 2021 saw the widespread distribution of virus throughout the country. It is unclear what the effect of this was on STEMI incidence and management. For more information please visit https://covid19.govt.nz/about-our-covid-19-response/history-of-the-covid-19-alert-system.

Inclusion criteria

Documented STEMI on ECG **and** a primary or secondary clinical impression from the list below:

- ST- elevation myocardial infarction
- Cardiac chest pain
- Myocardial ischaemia

Table 2: Out-of-Hospital STEMI patient inclusion criteria

Executive summary
Tuhinga whakarāpopoto nui

1,435 STEMI patients attended by emergency ambulance in the 12 month period

The median age was **67** years

32% female
68% male

STEMI diagnosis

36% of patients waited more than two hours from onset to calling 111

7 minutes Median time from EAS arrival to 12-lead ECG

62% of patients had first 12-lead ECG within 10 minutes

74%

13%

Primary PCI strategy

50 minutes Median time from EAS arrival to PCI Hospital

93% of patients arrived at a PCI capable hospital within 90 minutes of EAS arrival

Fibrinolysis strategy

31 minutes Median time from EAS arrival to fibrinolysis

75% of patients received fibrinolysis within 44 minutes of EAS arrival

Reperfusion strategies
Ngā rautaki whakarere anō toto

Primary PCI is the preferred reperfusion strategy for patients experiencing STEMI. Nationwide, 74% of out-of-hospital STEMI cases followed the primary PCI reperfusion strategy while 13% underwent fibrinolysis. The remaining 13% did not meet the criteria of either strategy. The destination hospital of patients treated by either strategy are shown in Figure 2.

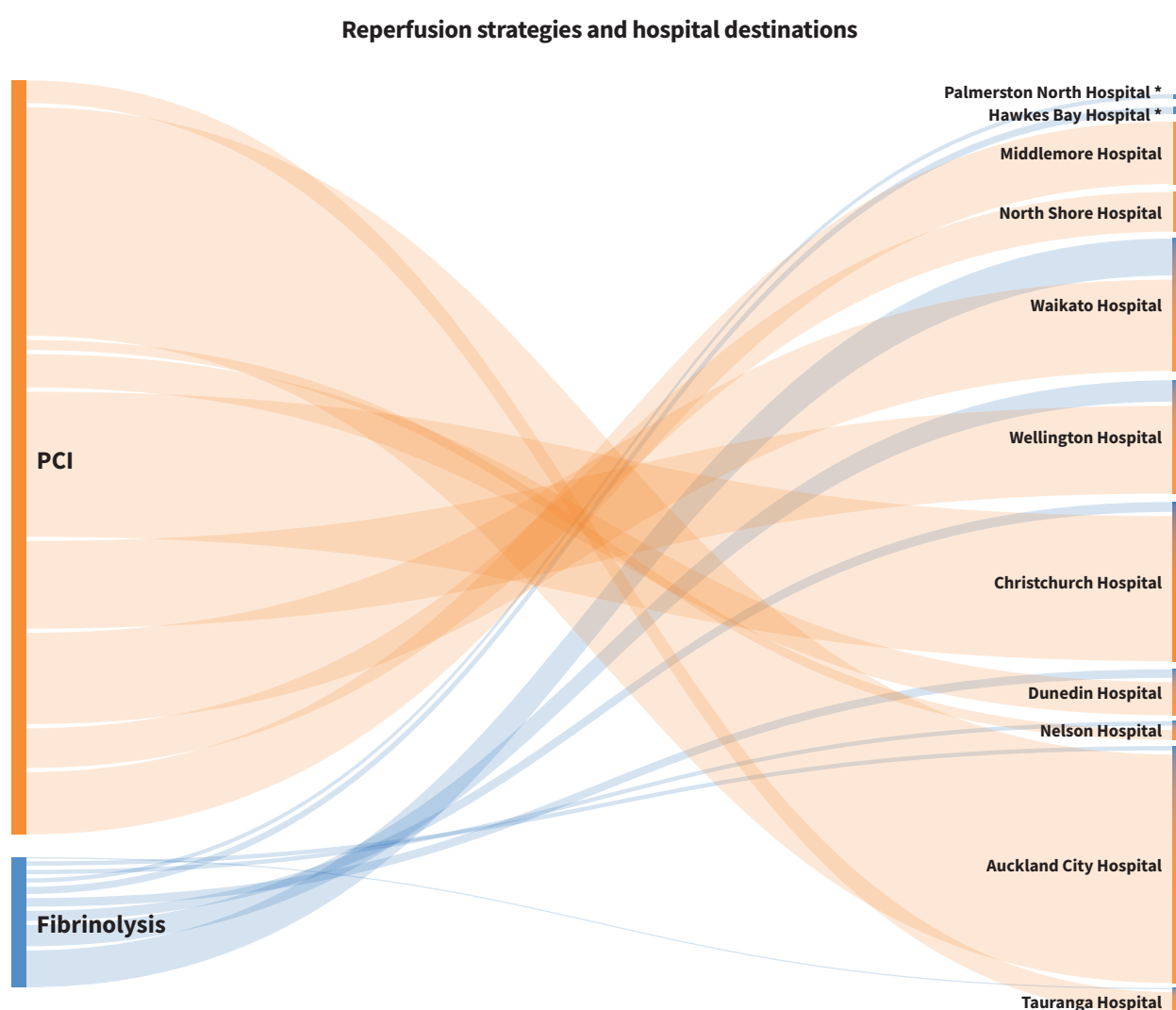**Reperfusion strategies and hospital destinations**

Figure 2. Sankey diagram of STEMI reperfusion strategies and hospital destinations

* Non PCI-capable hospital

Geographical distribution of STEMI cases undergoing either reperfusion strategy
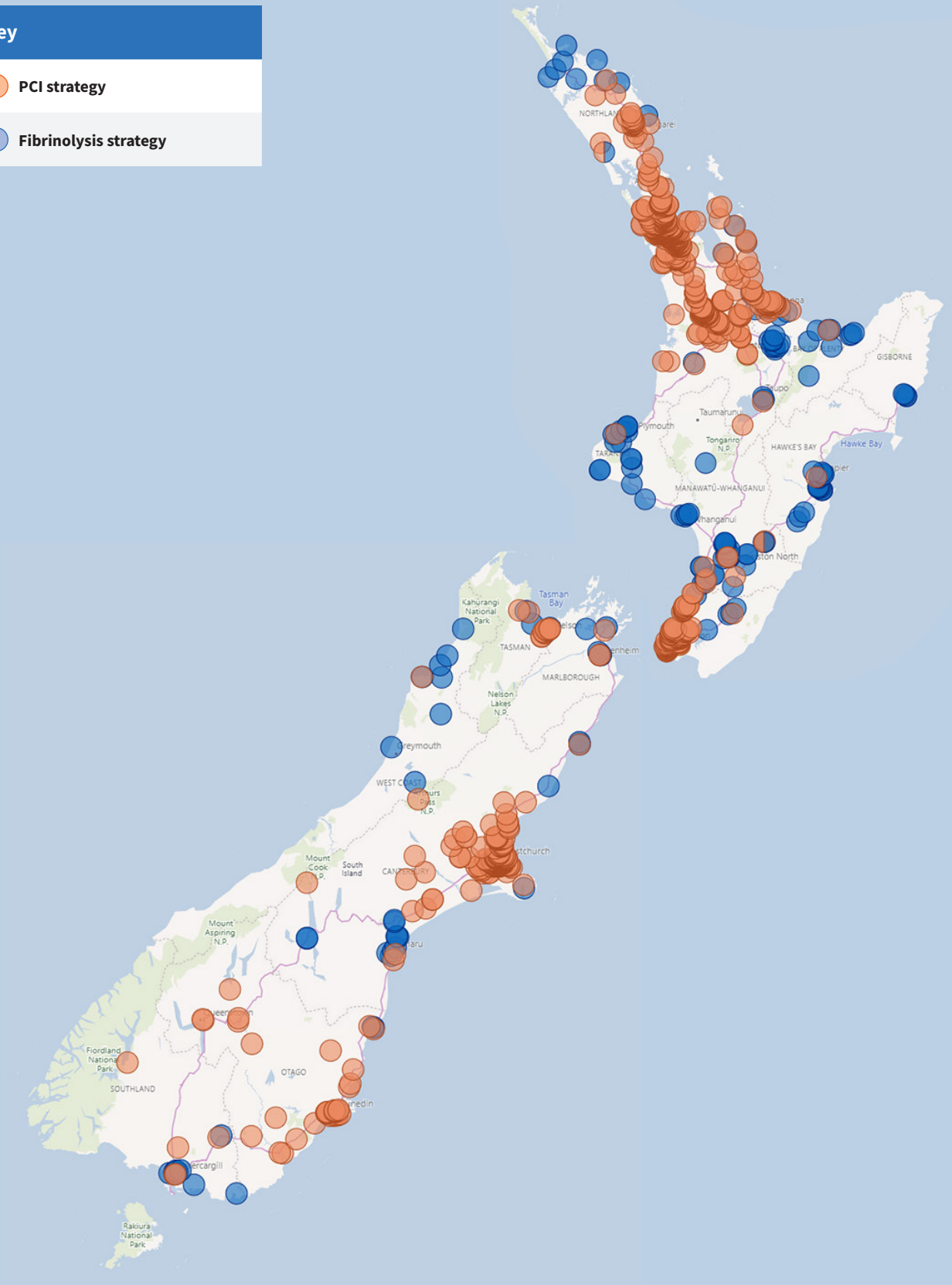
Time from ambulance arrival to reperfusion strategy

Fibrinolytic reperfusion therapy occurs earlier than in-hospital PCI services (Figures 3 and 4). Tenecteplase is the fibrinolytic drug used by New Zealand emergency ambulance service. While paramedics can provide fibrinolytic therapy without consultation, sometimes when STEMI diagnosis is unclear or cautions exist, consultation with the on-call doctor is required. Consultation is likely to delay fibrinolytic therapy. However, this delay was unable to be quantified as we currently cannot distinguish between autonomous and consulted fibrinolytic therapy.

Time from ambulance arrival to tenecteplase administration

Time from ambulance arrival to arrival at a PCI capable hospital

Figure 3. Time from ambulance arrival to tenecteplase administration for patients following the fibrinolysis reperfusion strategy

Figure 4. Time from ambulance arrival to arrival at a PCI capable hospital for patients following the Primary PCI reperfusion strategy

Timeline

The flowchart on the right shows the timeline of events for a typical out-of-hospital STEMI patient.

There is often a considerable delay in patients seeking care after the onset of their symptoms. The median time calculation of 61 minutes from onset of symptoms to 111 call includes patients who are assessed at other healthcare facilities prior to ambulance attendance.

Location

Of the STEMI incidents, 71% occurred in the patient's home (Figure 5). In 14% of cases the patient was located at a healthcare facility, indicating that they were assessed by another health professional prior to ambulance attendance.

Incident locations

- **71%** Home
- **14%** Healthcare facility
- **9%** Public
- **4%** Aged Care Facility
- **2%** Other

Figure 5. Location of incident where the patient was attended

Median time from onset of symptoms to 111 call
61 mins

Median time from 111 call to ambulance arrival
15 mins
(urban 14 minutes, rural 24 minutes)

Median time from ambulance arrival to first 12-lead ECG
7 mins

Median time from STEMI diagnosis to arrival at a PCI capable hospital
38 mins
(urban 36 minutes, rural 64 minutes)

Median time from STEMI diagnosis to prehospital fibrinolysis
21 mins

Year		2020/21	2021/22
Total number of events		1,511	1,435
Primary PCI strategy		68%	74%
Fibrinolysis strategy		16%	13%
Neither strategy		16%	12%
Median time from onset of symptoms to 111 call		63 mins	61 mins
Median time from 111 call to ambulance arrival		13 mins	15 mins
Median time from ambulance arrival to first 12-lead ECG		7 mins	7 mins
Median time from STEMI diagnosis to arrival at a PCI-capable hospital		36 mins	38 mins
Median time from STEMI diagnosis to prehospital fibrinolysis		25 mins	21 mins

Patient journey
Te Haerenga Tūroro

▬ Median scene time ▬ Median transport time

Median times for patients following the Primary PCI strategy

All
First ECG 7 minutes
29 mins
20 mins
49 mins Total time

Urban
First ECG 12 minutes
27 mins
18 mins
45 mins Total time

Rural
First ECG 7 minutes
37 mins
44 mins
81 mins Total time

0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120
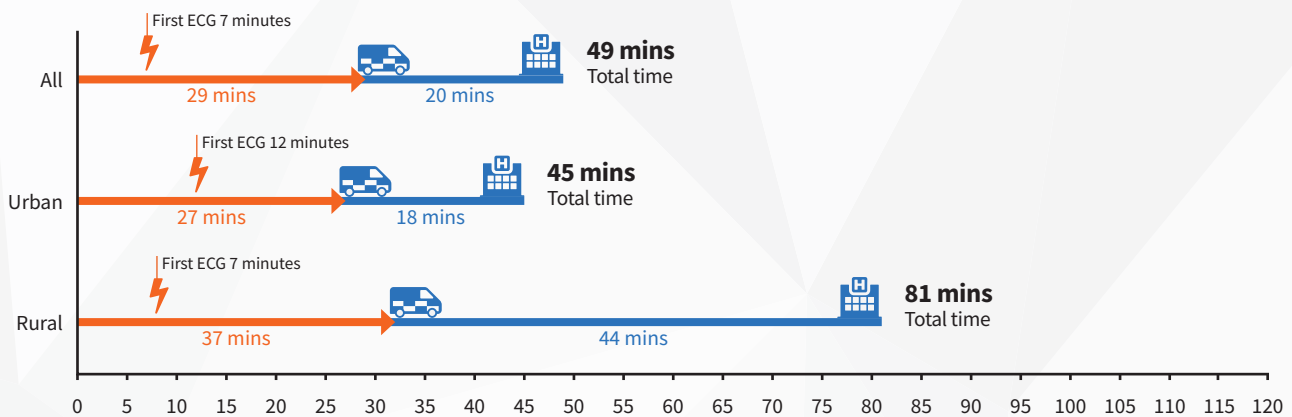
Figure 6. Median times for patients following the Primary PCI strategy

Median times for patients following the Fibrinolysis strategy

All
First ECG 7 minutes
Fibrinolysis 31 minutes
55 mins
50 mins
105 mins Total time

Urban
First ECG 6 minutes
Fibrinolysis 30 minutes
44 mins
64 mins
108 mins Total time

Rural
First ECG 9 minutes
Fibrinolysis 33 minutes
78 mins
42 mins
120 mins Total time

0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120
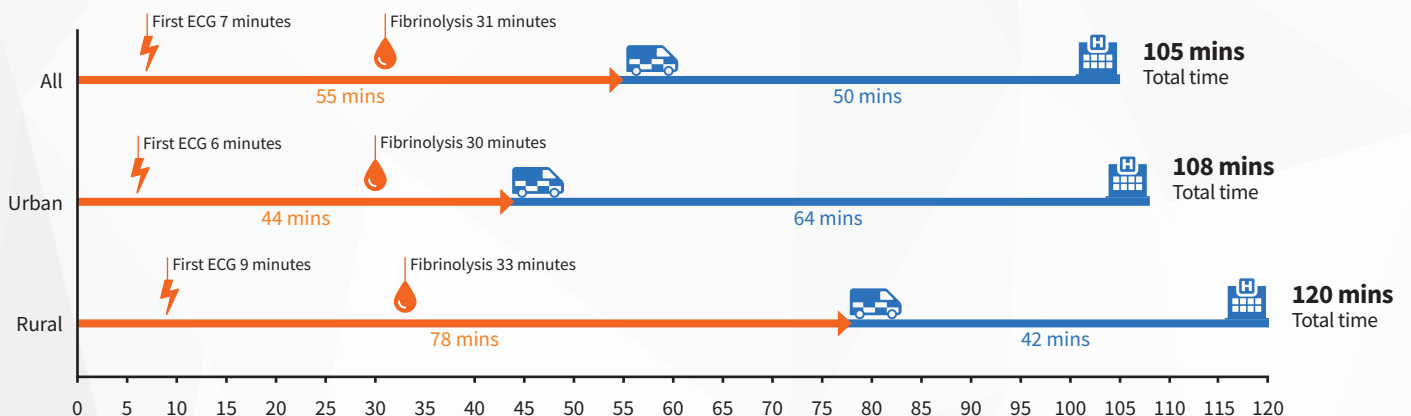
Figure 7. Median times for patients following the Fibrinolysis strategy

Patient demographics
Ngā hangapori tūroro

Given the propensity for small numbers among locality, ethnicity, and deprivation subgroups, this year's report includes last year's cohort to establish trends and reduce the effects of confounding variables.

Age
Māori and Pacific People experience STEMI at a younger age (Figure 8). Note that in all ethnicities, males experience STEMI at younger ages than females – with a median age difference of ten years.

The median ages amongst the no reperfusion strategy group were higher than both the Primary PCI and fibrinolysis strategy groups.

Age distribution

Male — Pacific People 55, NZ Māori 57, Asian 59, All Ethnicities (Median) 64, European 67 — 68%

Female — Pacific People 62, NZ Māori 63, Asian 68, All Ethnicities (Median) 74, European 76 — 32%
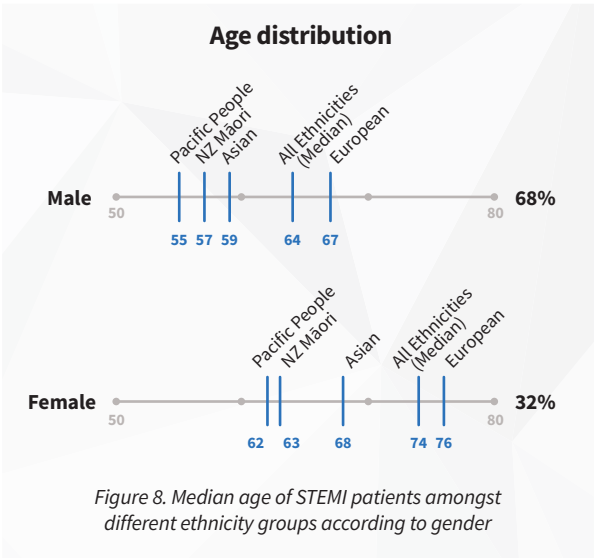
Figure 8. Median age of STEMI patients amongst different ethnicity groups according to gender

Strategy	Median age (years)
Primary PCI	66
Fibrinolysis	68
Neither	74

Rurality

Primary PCI and other specialised definitive cardiac interventions are only available in major urban hospitals throughout Aotearoa New Zealand. Populations living in rural communities are at especially high risk of geographical inequity in coronary care.

Rurality was defined using the Whitehead et. al [2] rural-urban geographic classification system.

While most patients in large urban centers access Primary PCI pathways, a meaningful number of patients living in smaller cities throughout New Zealand (particularly around the central North Island) still depend on prehospital fibrinolysis as their main reperfusion strategy (Figure 9).

Reperfusion strategies among rural populations have the expected lower proportion of patients following the Primary-PCI strategy, with the corresponding increase in patients undergoing pre-hospital fibrinolysis (Figure 9). The cumulative data over the last two reporting years shows close to a quarter of rural STEMI patients fall outside either reperfusion strategy.

Reperfusion strategy according to rurality
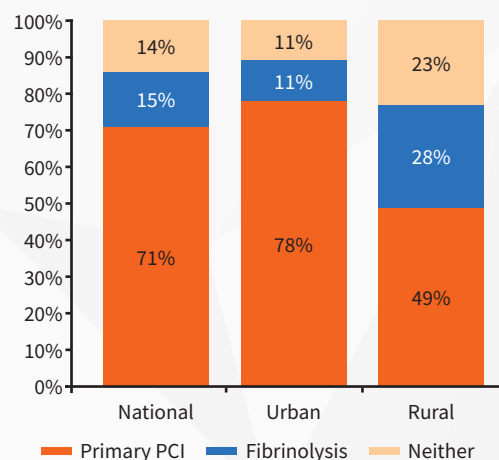
Figure 9. Cumulative reperfusion strategy according to rurality 2020 – 2022

Ethnicity

Europeans accounted for the majority of patients experiencing a STEMI (73%), followed by Māori (10%), Asian (10%) and Pacific People (6%) (Figure 10). The remaining 1% were Middle Eastern, Latin American, African, and other ethnicities.

Reperfusion strategies across different ethnicities demonstrate distinctive patterns. While Primary PCI remains the main reperfusion strategy across all ethnicities, Māori have the lowest proportion of Primary PCI, whilst Pacific People and Asians have the highest (presumably reflecting the predominance of urban living in these populations).

Cumulative ethnicity of patients experiencing a STEMI

73% European
10% NZ Māori
6% Pacific People
10% Asian
1% MELAA

Figure 10. Combined reperfusion strategy according to ethnicity

Reperfusion strategy according to ethnicity
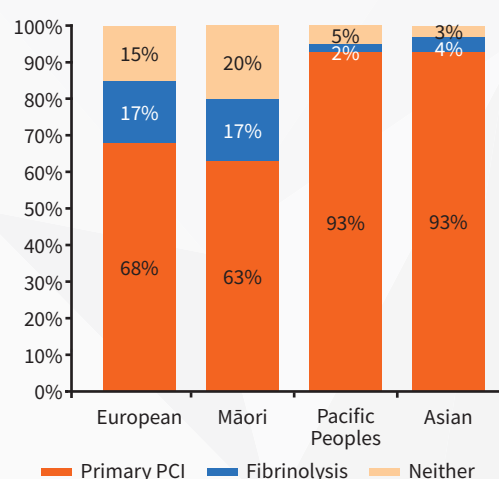
Figure 11. Cumulative reperfusion strategy according to ethnicity 2020 – 2022 (not including groups less than 1%)

Economic Deprivation

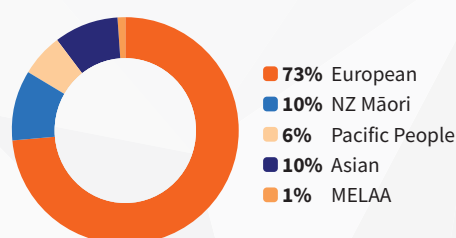The NZDep2018 is a measure of socioeconomic deprivation calculated using census data [3]. Some of the factors included in this measurement of deprivation are:

- no access to the internet,
- receiving a means tested benefit,
- household income below an income threshold,
- being 18–64 years old and unemployed,
- being 18–64 years old with no qualifications,
- not living in own home,
- a single parent family,
- household bedrooms less than occupancy threshold,
- and no access to a car.

The NZDep2018 quintiles range from Q1 – 5, where the least deprived 20% of areas are scored as Q1, and the most deprived 20% are scored as Q5.

Higher levels of socioeconomic deprivation are universally associated with worse access to care and health outcomes, and data presented in our reports appear to confirm this paradigm.

Not only does access to Primary PCI diminish with increasing deprivation, but the percentage of patients not receiving either reperfusion strategy increases strikingly.

Figure 12. National cumulative reperfusion strategy according to deprivation (2020 – 2022)
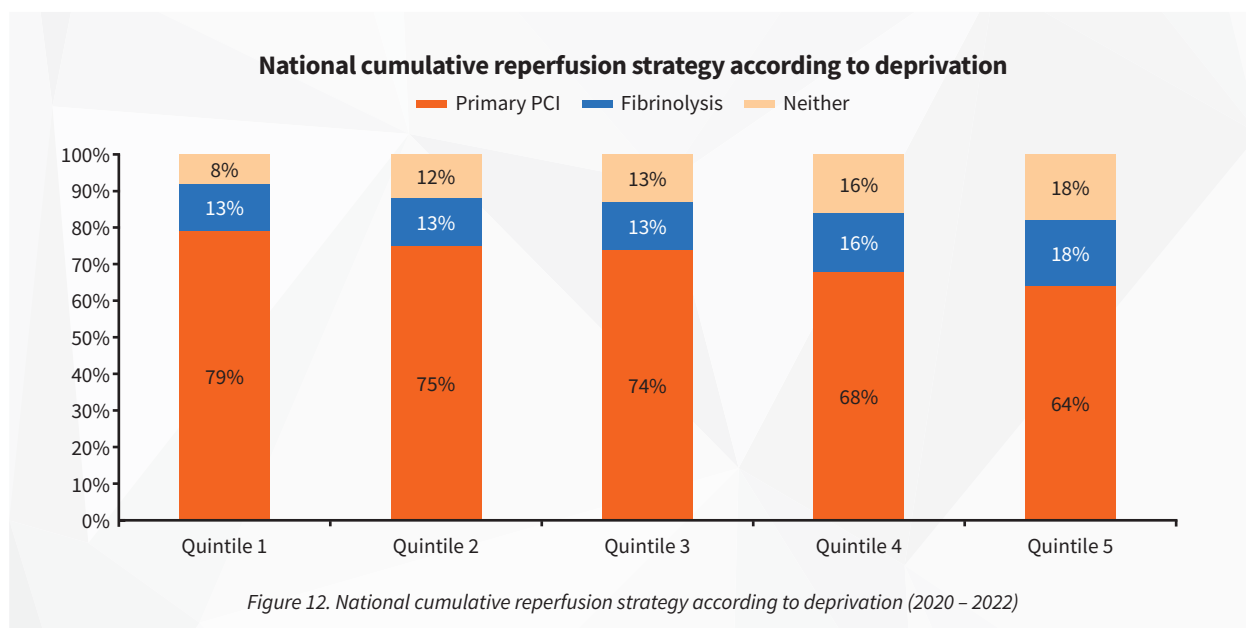
Neither reperfusion group
Te rōpū kāore anō rānei kia whakarere anō toto

Of the 1,435 STEMI patients in this reporting year, 177 (13%) were not enrolled in either of the reperfusion strategies. Most of these patients were transported to their domiciled hospital that did not have PCI-capability.

Median times for patients who did not follow a reperfusion strategy

All
First ECG 9 minutes
34 mins   17mins   **51 mins** Total time

Urban
First ECG 8 minutes
34 mins   11 mins   **45 mins** Total time

Rural
First ECG 10 minutes
34 mins   41 mins   **75 mins** Total time
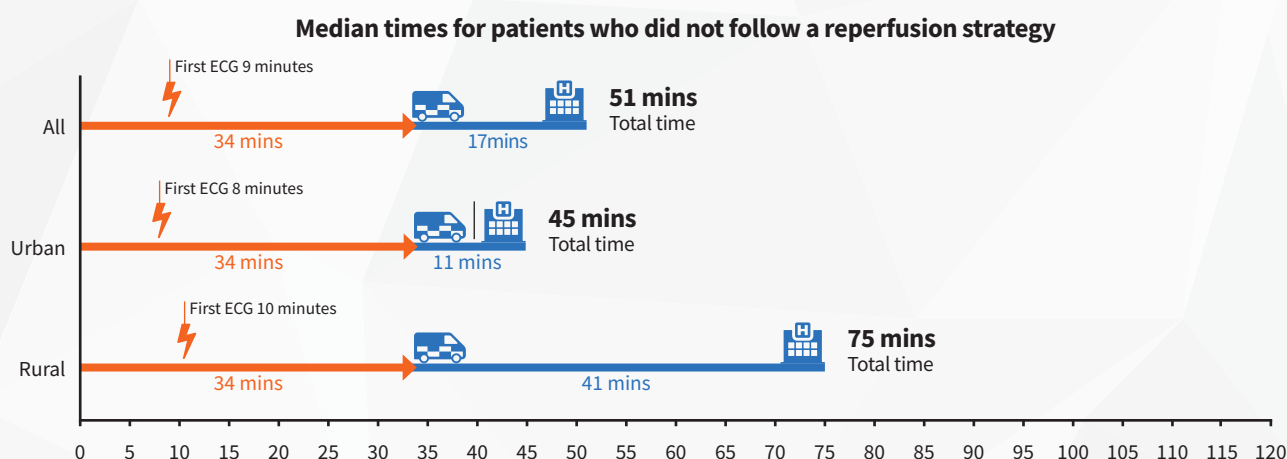
Figure 13. Median times for patients following neither strategy

Hospital destinations for patients not following a reperfusion strategy

Palmerston North Hospital
Hawkes Bay Hospital
Invercargill Hospital
Thames Hospital
Whangarei Hospital
Hutt Hospital
Whanganui Hospital
Whakatane Hospital
Waitakere Hospital
Ashburton Hospital
Timaru Hospital
Gisborne Hospital
Te Nikau Grey Hospital
Taranaki Hospital
Rotorua Hospital
Lakes District Hospital
Tokoroa Hospital
Dunstan Hospital
Wairau Hospital
Wairarapa Hospital
Taumarunui Community Hospital
Bay of Islands Hospital

Figure 14. Sankey diagram of hospital destination for STEMI patients who did not follow one of the two reperfusion strategies

Geographical distribution of STEMI cases undergoing neither reperfusion strategy
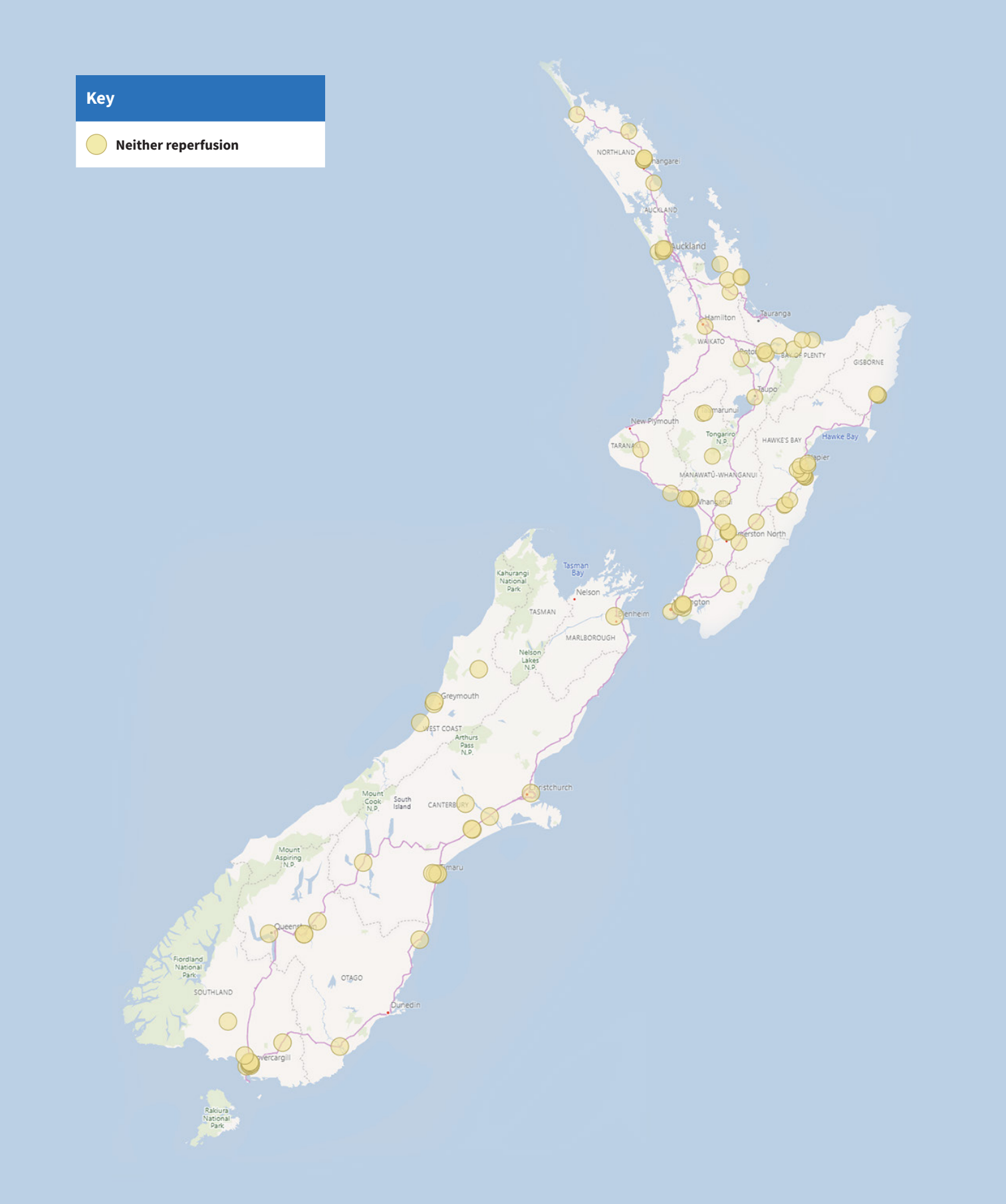
The two reperfusion strategies – Primary-PCI or fibrinolysis – are the optimal treatments for STEMI patients, and produce the best outcomes for the patients. Yet, in our 2021-2022 cohort of patients, there were 177 people (13%) who did receive either of these reperfusion options. They are the "Neither" group. Why was that? Were there good reasons why these patients did not receive reperfusion? Were there any who should have received reperfusion, but somehow missed out?

Essentially for this group of patients, reperfusion means prehospital fibrinolysis by paramedics, in localities where Primary PCI is not available (see the Sankey dist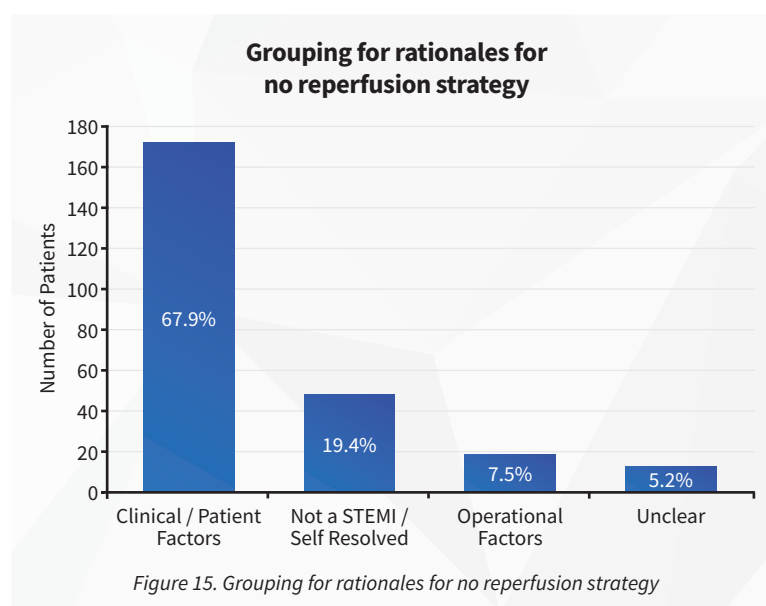ribution of these patients in Figure 14). To determine whether fibrinolysis was indicated in any of these Neither patients we performed a chart review for the last two reporting periods (2020/21 – 2021/22). Our chart review evaluated the patients' records, their 12-lead ECGs and reported signs and symptoms, and the documented rationale for not providing fibrinolysis.

This review of the Neither reperfusion group showed that trends for ethnicity, rurality and social deprivation were not too dissimilar from the Primary PCI or prehospital fibrinolysis groups. The majority of the Neither group were urban-dwelling Europeans, whose numbers rose as social deprivation increased. So, why did they not receive reperfusion therapy?

For most Neither patients, there were sound **clinical and individual human factors** that provided sufficient rationale for withholding fibrinolysis. Examples included: advanced age, severe comorbidity, and borderline or evolving ECG changes not yet meeting STEMI criteria. These were the most common underlying reasons documented in the ePRF records. The next most common reason was STEMIs that were self-resolved or ultimately not classified as true STEMIs (i.e. STEMI mimics). Cases categorised as "Unclear diagnosis" often represented atypical complex presentations where the balance of risk was in favour of withholding fibrinolysis (i.e. suspected aortic dissection). All of the above demonstrate paramedics making the right judgement, exercising caution in cases that are not clear cut, and knowing when to withhold treatment. It is reassuring that paramedics are showing this level of correct clinical decision-making.

Grouping for rationales for no reperfusion strategy

Figure 15. Grouping for rationales for no reperfusion strategy

Clinical / Patient Factors	Operational Factors
Very frail / comorbid	Very close to ED
Evolving / criteria not met	Medical centre fibrinolysis
Unclear diagnosis	No backup / no kit
Missed opportunity	No helicopter available / weather
Short life expectancy	
Onset >12hrs / subacute	
Contraindicated	
Patient refused	
Relative contraindication	
Dependent for ADLs	
No IV access	

However, our case review also showed up some areas where there is room for service improvement. Under **"operational factors"**, while the weather may be beyond the ambulance service's control, things like the unavailability of a kit or no fibrinolysis-trained crew meant a few patients did not have the opportunity to receive best practice treatment. Similarly, there were cases of inadequate documentation where no rationale was recorded for why fibrinolysis was withheld; we labelled these "unclear reason". Lastly, there were 21 "missed opportunity" cases where the ECG criteria and clinical presentation strongly supported the presence of a STEMI, but no reperfusion strategy was provided by the attending crew.

The following tables present in detail the identified rationales for patients not meeting clear or having borderline STEMI ECG criteria across ethnicity, rurality and deprivation.

Clinical rationale occurence across ethnicity

Rationale	European	NZ Māori	Pacific People	Asian	Total
Not a STEMI	28	4		1	33
Very frail / comorbid	26	2			28
Evolving / criteria not met	23	3		1	27
Unclear diagnosis / disagreement	21	1			22
Missed opportunity	20	1			21
Onset > 12 hrs / subacute	11	3	2	1	17
Short life expectancy	11	4		1	16
Contraindicated	12	2	2		16
STEMI self-resolved	13	3			16
Unclear reason	10		1		11
Patient refused	8	3			11
Very close to ED	3	3			6
No backup / no kit	4	2			6
Relative contraindication	6				6
No helicopter available / weather	3	1			4
Dependent for ADLs	4				4
Medical centre fibrinolysis	1			1	2
Other	2				2
No IV access	1				1
Total	**207**	**32**	**5**	**5**	**249**

Clinical rationale occurence across rurality

Rationale	Urban	Rural	Total
Not a STEMI	17	16	33
Very frail / comorbid	18	10	28
Evolving / criteria not met	18	9	27
Unclear diagnosis / disagreement	13	9	22
Missed opportunity	16	5	21
Short life expectancy	14	3	17
Onset >12hrs / subacute	12	5	17
Contraindicated	11	5	16
STEMI self-resolved	10	6	16
Unclear reason	5	6	11
Patient refused	9	2	11
Very close to ED	6	1	7
No backup / no kit	2	4	6
Relative contraindication	6		6
No helicopter available / weather	3	1	4
Dependent for ADLs	1	3	4
No IV access	1	1	2
Medical centre fibrinolysis		2	2
Other	1	1	2
Total	**163**	**89**	**252**

Clinical rationale occurence across deprivation quintiles

Rationale	Q1	Q2	Q3	Q4	Q5	Total
Not a STEMI	1	7	7	8	10	33
Very frail / comorbid		6	4	9	9	28
Evolving / criteria not met	2	5	8	5	7	27
Unclear diagnosis / disagreement	2	3	7	6	4	22
Missed opportunity	2	4	1	7	7	21
Short life expectancy	1	2	3	2	9	17
Onset >12 hrs / subacute		2	3	6	6	17
Contraindicated	3	3	4	3	3	16
STEMI self-resolved	4	1	5	4	2	16
Unclear reason	2	2	2	1	4	11
Patient refused	2		1		8	11
Very close to ED	1	1		4	1	7
No backup / no kit	1			1	4	6
Relative contraindication		1	1	2	2	6
No helicopter available / weather				2	2	4
Dependent for ADLs			1	2	1	4
No IV access					2	2
Medical centre fibrinolysis			1		1	2
Other			1	1		2
Total	**21**	**37**	**49**	**63**	**82**	**252**

Conclusion
Mutunga

This is the second Aotearoa New Zealand Out-of-Hospital STEMI report. The data presented in this report shows that paramedics continue to deliver lifesaving coronary reperfusion to STEMI patients across the motu. Our report continues to build on our Aotearoa New Zealand Out-of-Hospital STEMI registry, identifying both successes and areas for improvement in prehospital STEMI care.

Glossary of terms

ADL	Activities of daily living
Adult	Patients aged 15 years or older
EAS	Emergency ambulance service
ECG	12-lead electrocardiogram
ED	Emergency department
PCI	Percutaneous coronary intervention
STEMI	ST-elevation myocardial infarction

References

[1]   Ministry of Health. 2018. Cardiovascular disease. https://www.health.govt.nz/our-work/populations/maori-health/tatau-kahukura-maori-health-statistics/nga-mana-hauora-tutohu-health-status-indicators/cardiovascular-disease

[2]   Whitehead J, Davie G, de Graaf B, Crengle S, Fearnley D, Smith M, Lawrenson R, Nixon G. Defining rural in Aotearoa New Zealand: a novel geographic classification for health purposes. New Zealand Medical Journal. 2022 Aug 5;135(1559):24-40.

[3]   Atkinson, J., C. Salmond, and P. Crampton, NZDep2018 index of deprivation. Wellington: Department of Public Health, University of Otago, 2019.