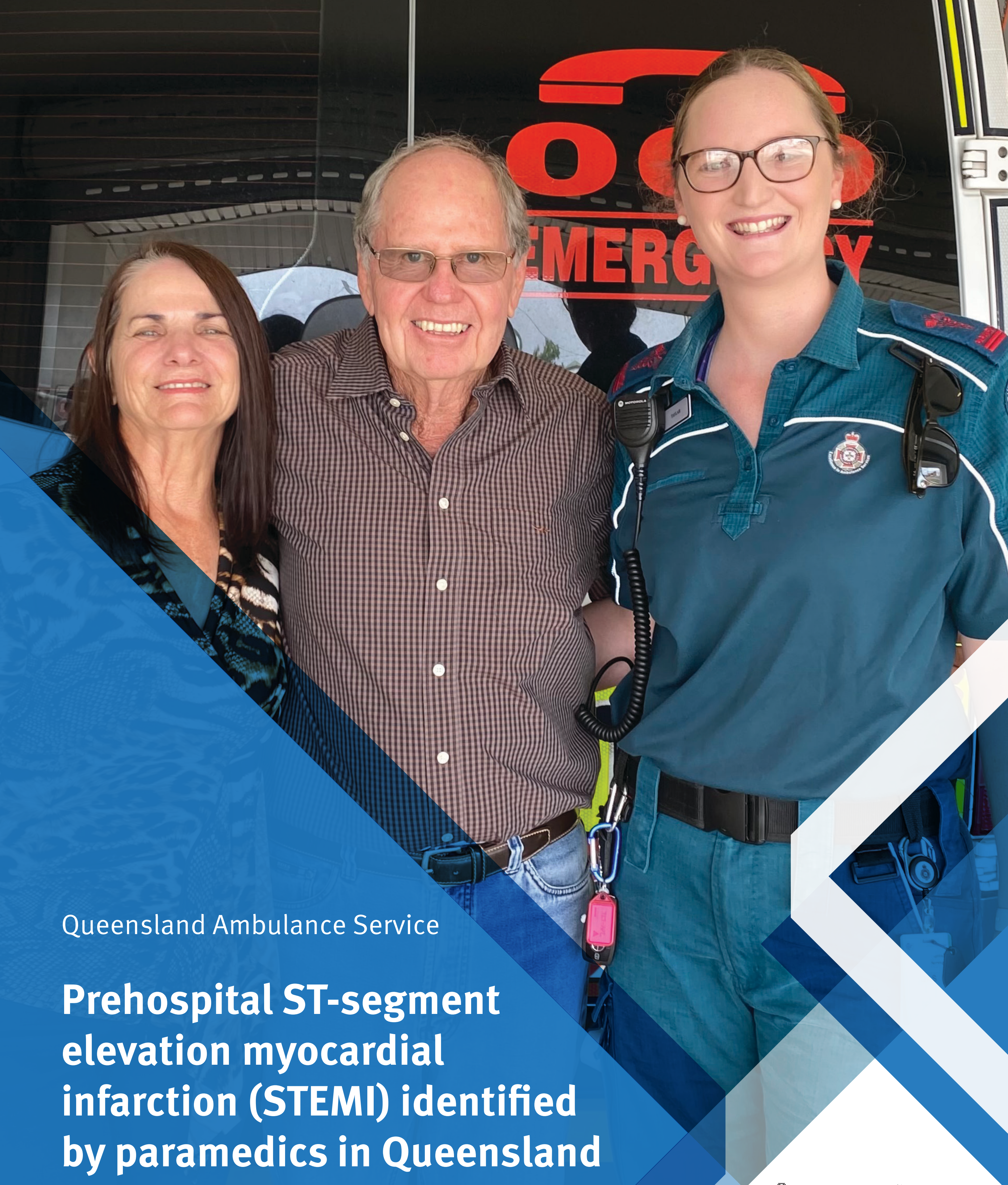

Queensland Ambulance Service

Prehospital ST-segment elevation myocardial infarction (STEMI) identified by paramedics in Queensland

2019-2020 report

Queensland Government

1417QAS

Frank Johnson reunited with paramedic Taylah Schutt who responded when Frank was suffering a heart attack. As a single officer responding to a call for chest pain, Taylah identified that Frank was suffering a STEMI. Moments later, he went into cardiac arrest. Taylah provided life-saving defibrillation before commencing fibrinolytic medications to ensure that Frank had the best possible chance of recovery. After five days of treatment in Mackay Base Hospital, Frank was able to return home before visiting Sarina Ambulance Station to say a very special thank you to Taylah. This wonderful outcome for Frank, his family and friends, is a superb demonstration of the positive impact the integrated STEMI treatment pathways are having for patients all across the state.

This report is authored by the Information Support, Research and Evaluation (ISRE) Unit,

Queensland Ambulance Service.

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Abbreviations

CPR	Cardiopulmonary Resuscitation
ECG	Electrocardiogram
FMC	First Medical Contact
FY	Financial Year
GCS	Glasgow Coma Scale
IQR	Interquartile Range
LASN	Local Ambulance Service Network
OHCA	Out-of-Hospital Cardiac Arrest
PCI	Percutaneous Coronary Intervention
QAS	Queensland Ambulance Service
QCOR	Queensland Cardiac Outcomes Registry
ROSC	Return of Spontaneous Circulation
SD	Standard Deviation
STEMI	ST-Segment Elevation Myocardial Infarction

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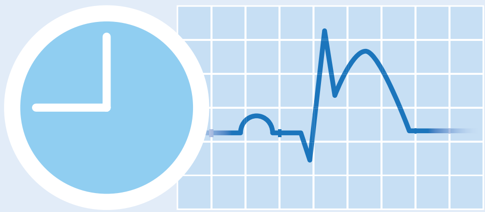
Key facts at a glance

1283 STEMI patients

identified and treated by paramedics 1 July 2019 - 30 June 2020

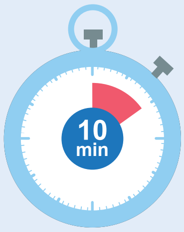
6 Minutes

Median time from scene arrival to first 12-lead ECG



82.8%

Patients had first 12-lead ECG performed within 10 minutes of scene arrival



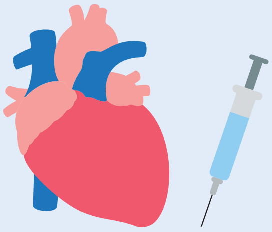
64.7%

Received prehospital reperfusion drug administration

Percentage of direct PCI referral patients achieving reperfusion within 90 minutes following STEMI identification

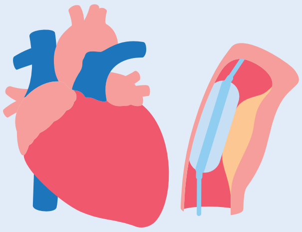
97.7%

30-day survival rate in patients receiving prehospital fibrinolysis



99.1%

30-day survival rate in direct PCI referral patients



1 About this report

This report describes information on the response, treatment, and conveyance for ST-segment elevation myocardial infarction (STEMI) patients identified by Queensland Ambulance Service (QAS) paramedics for the period between 1 July 2019 to 30 June 2020 (financial year 2019/20). It also extends to provide a detailed description of important in-hospital elements of STEMI care, angiographic profile and survival outcomes through analysis of complementary data from the Queensland Cardiac Outcomes Registry (QCOR), an initiative of Clinical Excellence Queensland.

Also presented as a special focus in this report is an analysis of STEMI patients who suffered out-of-hospital cardiac arrest (OHCA), including: (1) STEMI patients who suffered OHCA and received intra-arrest fibrinolysis in the field; and (2) STEMI patients who suffered OHCA and were treated with primary percutaneous coronary intervention (PCI) following resuscitation.

2 Patient demographics

In FY 2019/20, QAS paramedics identified and treated a total of 1283 STEMI patients. This represents an absolute increase of 203 cases (or 18.8% relative increase) compared to FY 2018/19. The majority of patients were male (72.3%), being on average 8 years younger than females (Figure 1). 63.7% of STEMI cases occurred in metropolitan areas (Figure 2).

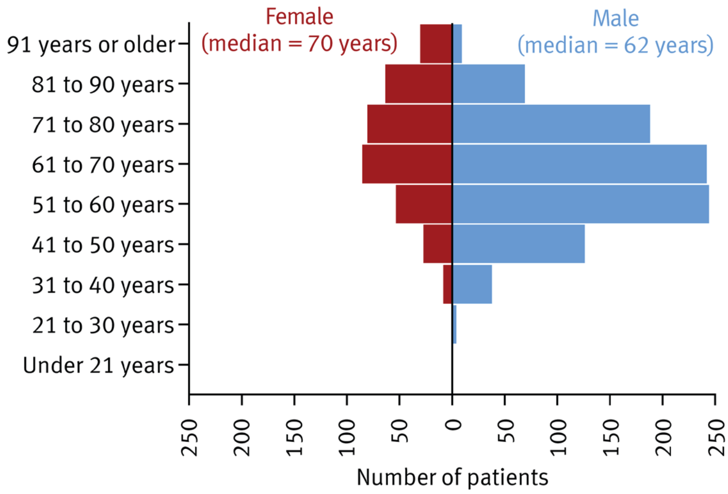


Figure 1. Age distribution by gender.

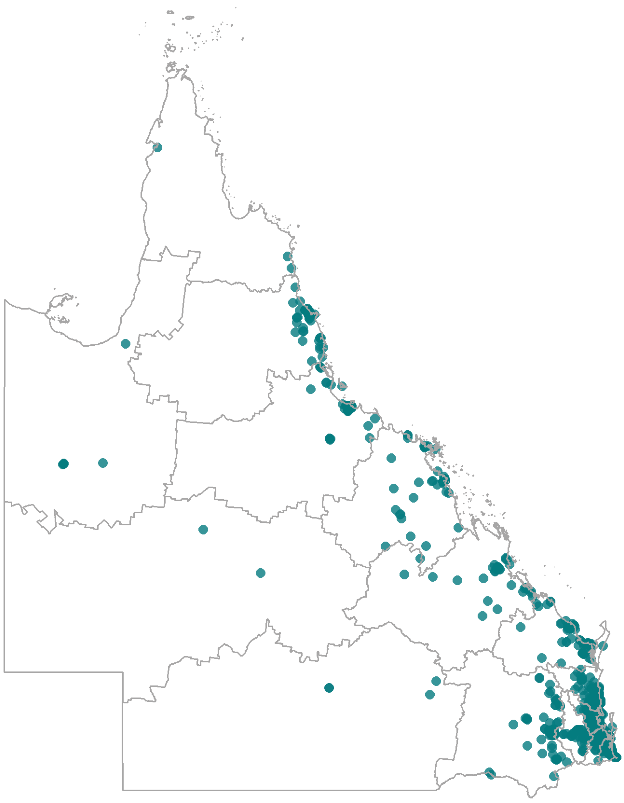


Figure 2. Geographic location of individual cases. Each dot represents a case.

3 Angiographic profile

Of the 1283 STEMI patients identified and treated by paramedics, 667 had information on culprit vessel locations. The right coronary artery was the most common culprit vessel (48.0% of patients), followed by the left anterior descending artery (41.5%) and circumflex coronary artery (14.7%) (Figure 3). Single vessel disease was found in 91.5% of patients.

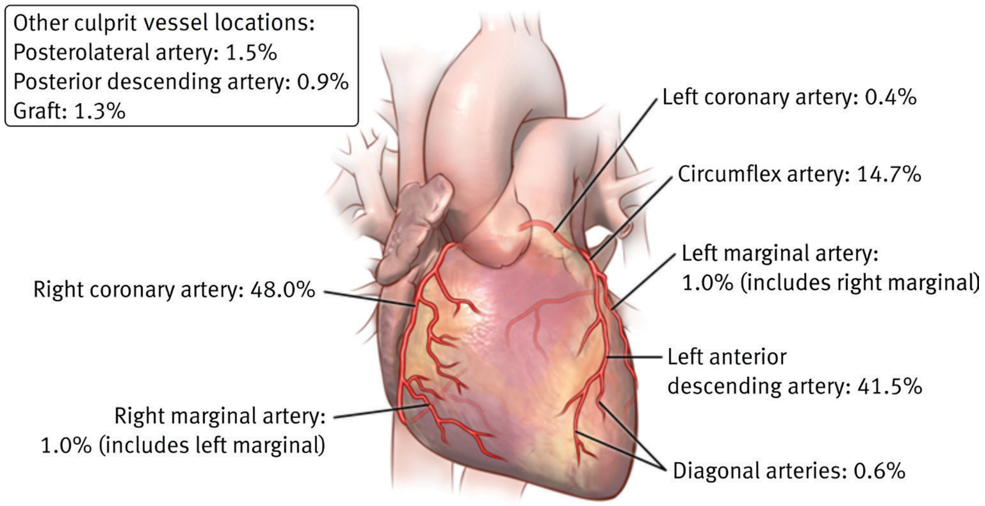


Figure 3. Culprit vessel locations. A patient could have more than one occluded artery.
Image source: Johns Hopkins Medicine.[1]

4 Reperfusion pathways and hospital destinations

Statewide, 64.7% (830/1283) of identified STEMI patients received a form of prehospital reperfusion therapy (direct referral for primary PCI or prehospital fibrinolysis) (Figure 4). Around half (50.6%) of patients received direct PCI referral, and one-in-seven (14.1%) received prehospital fibrinolysis administration. Similar to the statewide patterns, direct PCI referral was the main form of prehospital reperfusion therapy in metropolitan areas; whereas a slightly higher proportion of patients in rural areas received prehospital fibrinolysis than direct PCI referral (Figure 4).

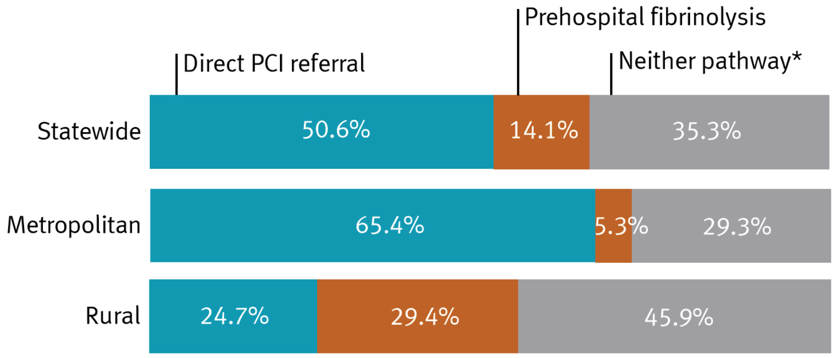


Figure 4. QAS prehospital reperfusion pathways. *All patients who did not receive either form of prehospital reperfusion therapy was due to close proximity to hospital and/or clinical contraindications within the QAS reperfusion guidelines.

Among the PCI-capable hospitals that have a QAS direct PCI referral pathway, the Princess Alexandra Hospital and The Prince Charles Hospital were the most common destinations, collectively receiving approximately half (50.7%) of direct PCI referral cases (Figure 5).

Almost half (47.8%) of prehospital fibrinolysis patients were directly transported to a PCI-capable hospital, with The Prince Charles Hospital accounting for the largest proportion of these cases (Figure 6). Nearly all prehospital fibrinolysis patients who were initially transported to a non-PCI hospital were subsequently transferred to a PCI-capable facility, with aeromedical retrieval being the predominant mode of inter-hospital transfer (Figure 7).

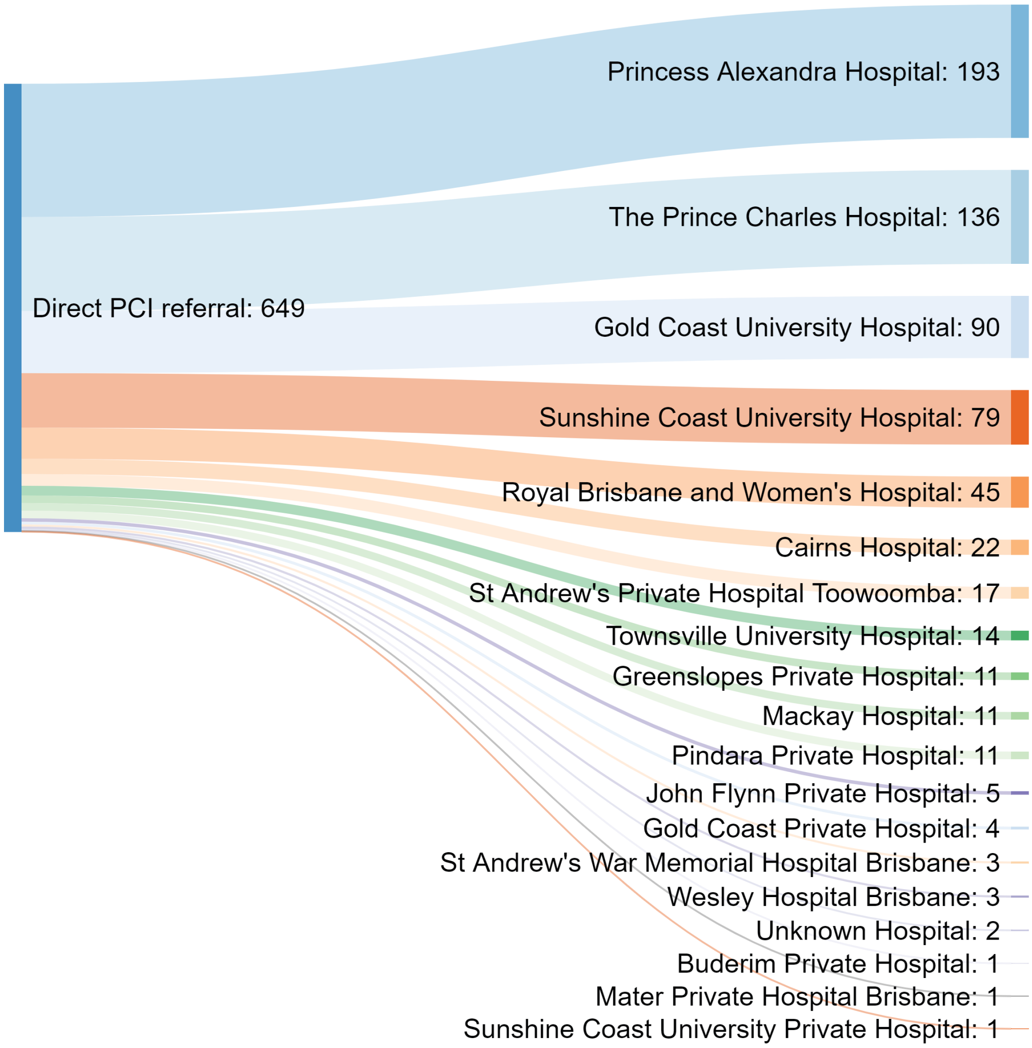


Figure 5. Receiving hospitals of QAS direct PCI referral patients.

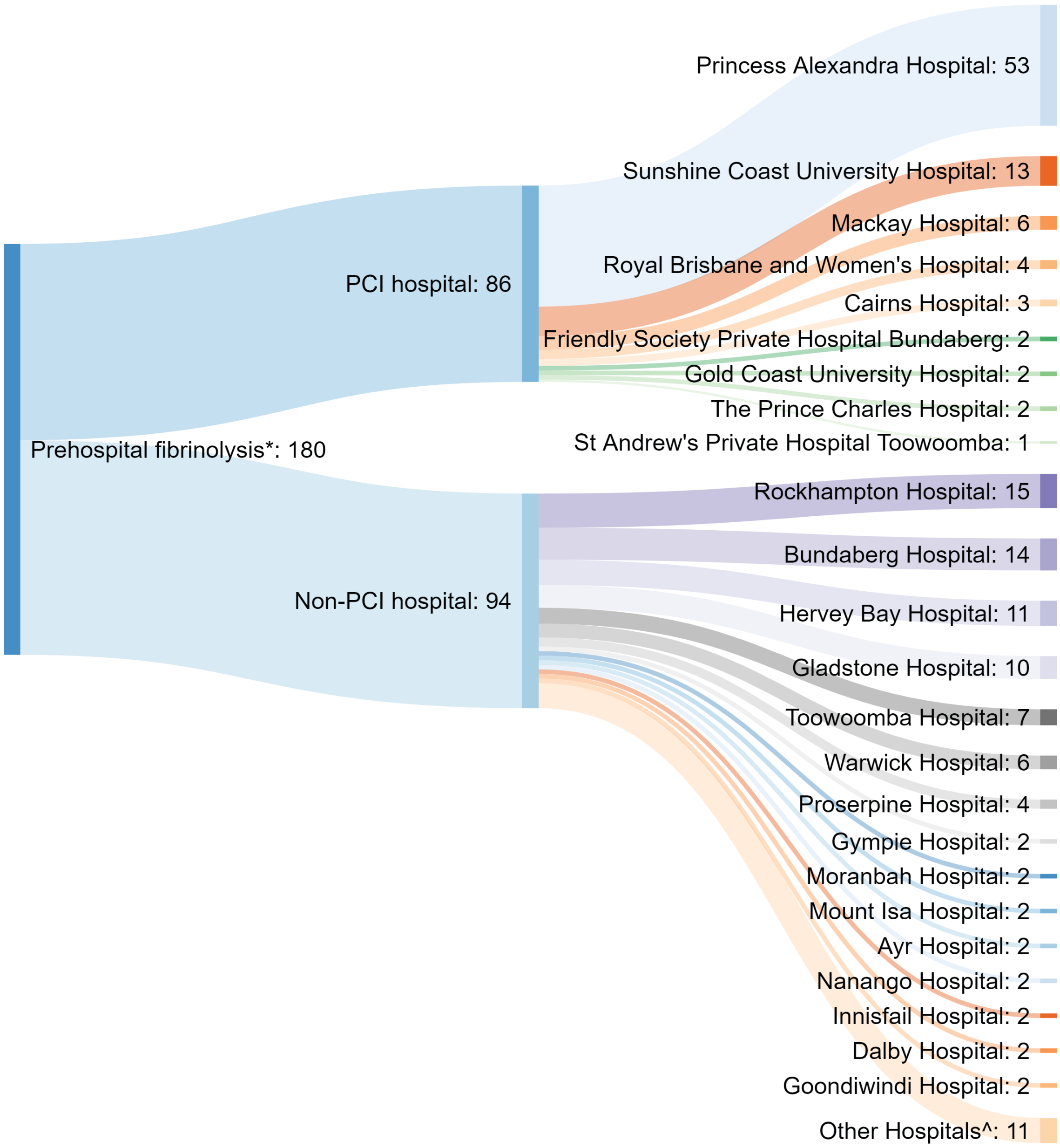


Figure 6. Receiving hospitals of QAS prehospital fibrinolysis patients. These represent hospital destinations to which paramedics directly transported patients. Subsequent transfer to another hospital might have occurred, especially transfer to a PCI hospital among patients who were initially transported to a non-PCI facility. *Does not include 1 case who died at scene and therefore was not transported. ^One case for each hospital.

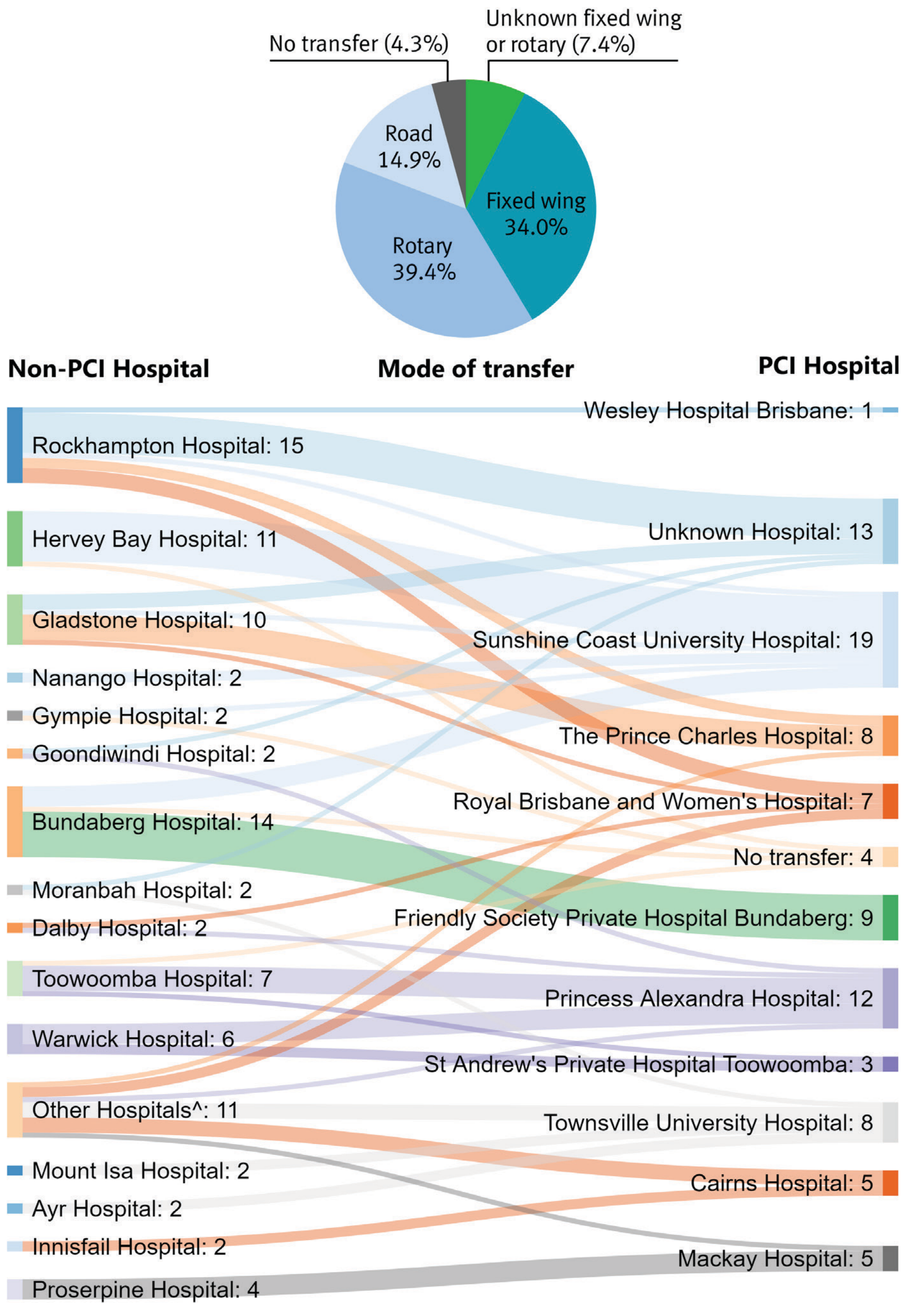


Figure 7. Subsequent transfer, and mode of transfer, of QAS prehospital fibrinolysis patients who were initially transported to a non-PCI hospital. ^One case for each hospital.

Statewide, 35.3% (453/1283) of patients did not receive either form of prehospital reperfusion therapy due to close proximity to hospital and/or clinical contraindications within the QAS reperfusion guidelines (Figure 4). The complete list of medical contraindications is shown in Figure 8. The most common contraindication to prehospital reperfusion therapy was the patient being either pain free or experiencing atypical chest pain (19.7% of the recorded contraindications). This was followed by an altered conscious level (Glasgow Coma Scale < 15; 17.7%) and pain duration greater than 6 hours (13.1%). These patients were still identified for prenotification to the receiving facility to ensure rapid assessment and treatment upon arrival. Around two-thirds (65.2%) of these patients were transported directly to a PCI-capable hospital (Figure 9).

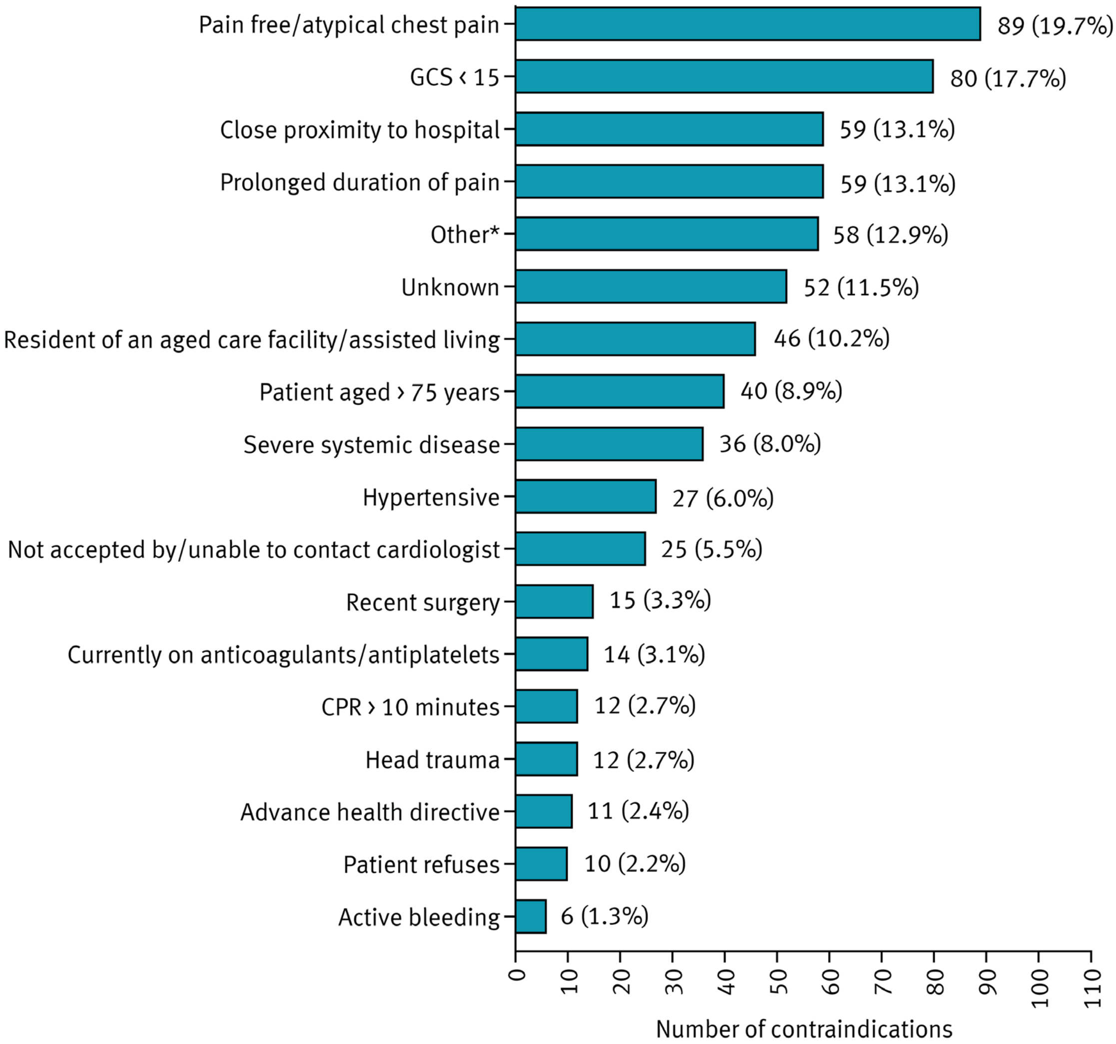


Figure 8. Contraindications to prehospital reperfusion therapy within QAS reperfusion guidelines. A patient could have more than one contraindication. *Includes wide QRS complex; unable to establish medical history; unable to gain intravenous access; unable to complete reperfusion checklist due to language barrier; spontaneous coronary artery dissection; recent transient ischemic attack; prior intracranial haemorrhage; posterior myocardial infarction; suspected abdominal aortic aneurysm; patient did not cooperate; pacemaker; not approved/authorised by QAS Clinical Consultation Line; QAS Clinical Consultation Line not available; Critical Care Paramedic backup not available; no "Acute Myocardial Infarction" displayed on corpuls printout; location of blockage requiring bypass; receiving hospital instructing fibrinolysis to be done in-hospital; patient died at scene; dementia; family wish; deep vein thrombosis; cerebral disease; and cardiogenic shock.

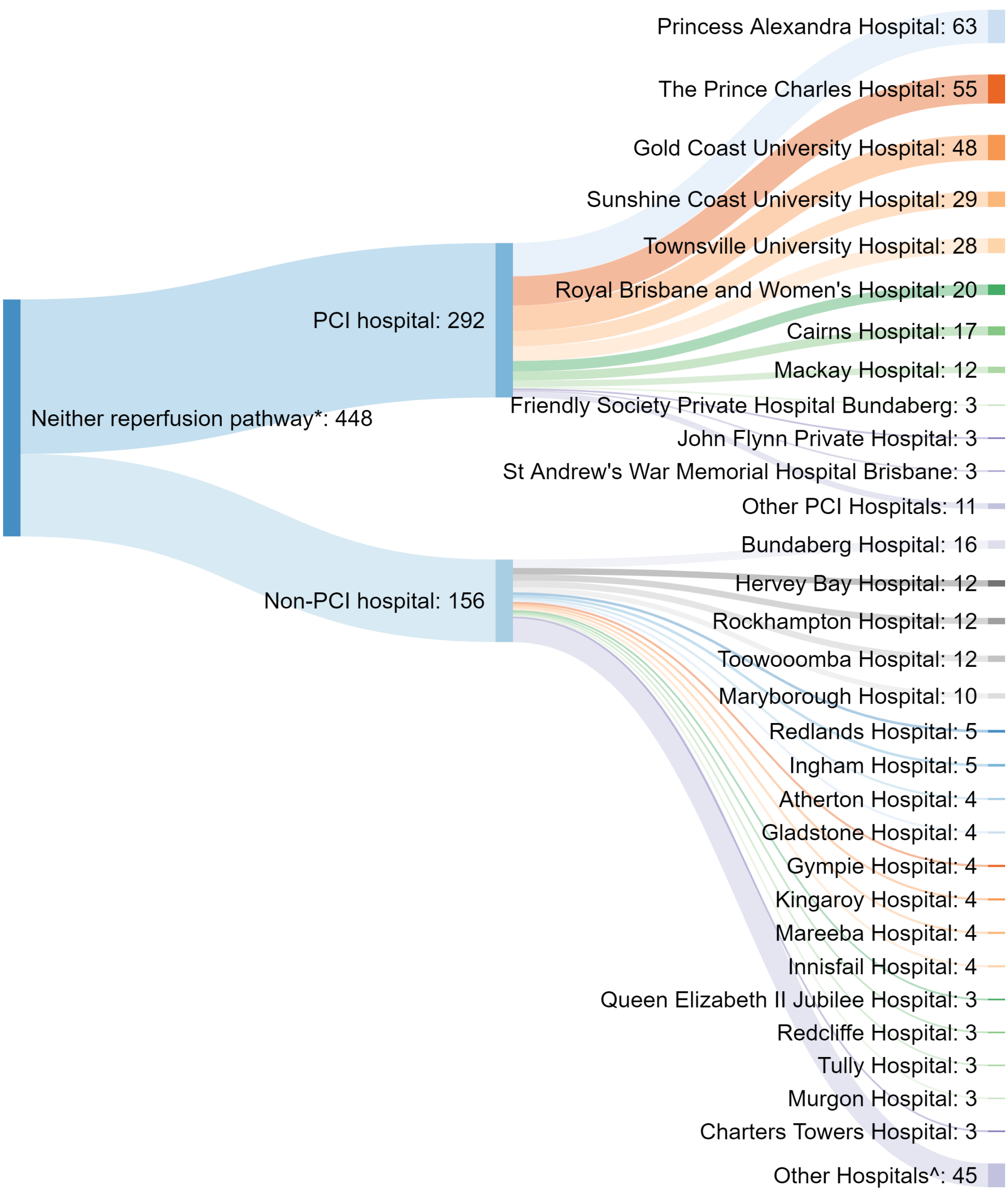


Figure 9. Receiving hospitals of patients who did not receive either form of QAS prehospital reperfusion therapy. These represent hospital destinations to which paramedics directly transported patients. Subsequent transfer to another hospital might have occurred, especially transfer to a PCI hospital among patients who were initially transported to a non-PCI facility. *Did not include 5 non-transported cases; 3 of which died at scene, and the remaining 2 refused transport. ^One or two cases for each hospital.

5 Time from FMC to first 12-lead ECG

The median time from first medical contact (FMC), defined as first paramedic arrival at scene, to performance of first 12-lead electrocardiogram (ECG) was 6 minutes for both metropolitan and rural areas. This applied across all Local Ambulance Service Network (LASN) areas with the exception of Townsville and Mackay LASNs which had a median time of 7 and 5 minutes, respectively (Figure 10). Statewide, 82.8% of patients had a first 12-lead ECG performed within the 10-minute benchmark, a 2.1 percentage point improvement from the previous FY (2018/19).

The percentages of patients in metropolitan and rural areas who had their first 12-lead ECGs performed within 10 minutes of FMC were 83.3% and 81.9% (p = 0.538), respectively (Figure 11). Whilst the proportion of patients in metropolitan areas who met the 10-minute benchmark was comparable to the previous FY, there was a notable improvement in rural areas (81.9% FY 2019/20 versus 76.3% FY 2018/19) (Figure 11). For most patients (87.1%), STEMI was identified on the first 12-lead ECG.

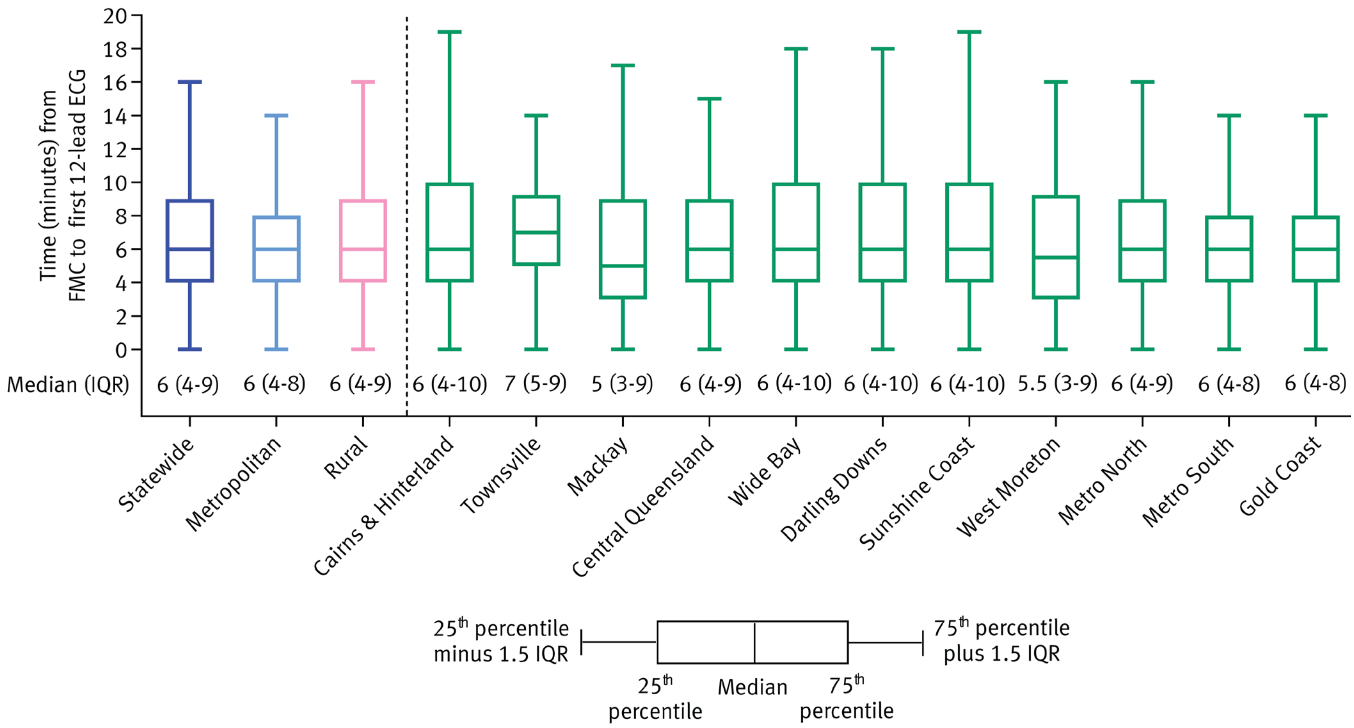


Figure 10. Time interval from FMC to QAS first 12-lead ECG. Torres and Cape (3 cases), North West (6), Central West (2) and South West (4) LASN areas were not included in this analysis due to the small number of cases.

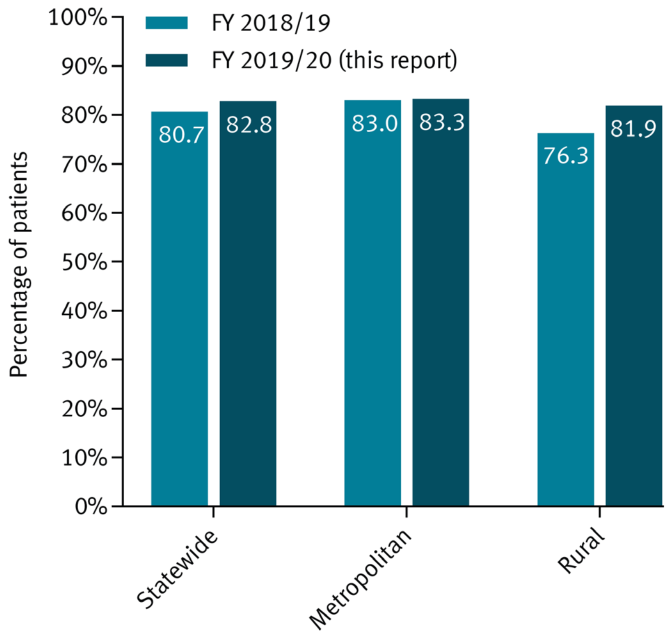


Figure 11. Percentage of patients who had QAS first 12-lead ECG performed within 10 minutes of FMC.
Comparison between FY 2019/20 (this report) and FY 2018/19.

6 Time from STEMI identification to reperfusion treatment

For prehospital fibrinolysis patients, the median time (interquartile range, IQR) from STEMI identification to tenecteplase administration was 33 (25-43) minutes. For direct PCI referral patients, reperfusion time was defined as the time of TIMI-3 flow. TIMI Grade Flow is a scoring system referring to levels of coronary blood flow assessed during PCI, with a score of 3 indicating normal flow. Where this timestamp was not available, time of first balloon inflation or of first device deployment was used as a surrogate for reperfusion time. To examine temporal changes in prehospital and in-hospital components of reperfusion times, data from July 2016 to June 2020 were analysed. Across this period, the statewide median time from QAS first STEMI 12-lead ECG to reperfusion was 81 minutes (Figure 12). There was a trend of a shortening time interval between STEMI identification and reperfusion across the years (Figure 12). Specifically, the statewide median time from STEMI identification to reperfusion reduced from 87 minutes in FY 2016/17 to 79 minutes in FY 2019/20. The proportions of QAS direct PCI referral patients who achieved reperfusion within 90 minutes following prehospital STEMI identification increased over time, improving from 50.0% in FY 2016/17 to 59.6% in FY 2018/19 and 63.3% in FY 2019/20 (Figure 12).

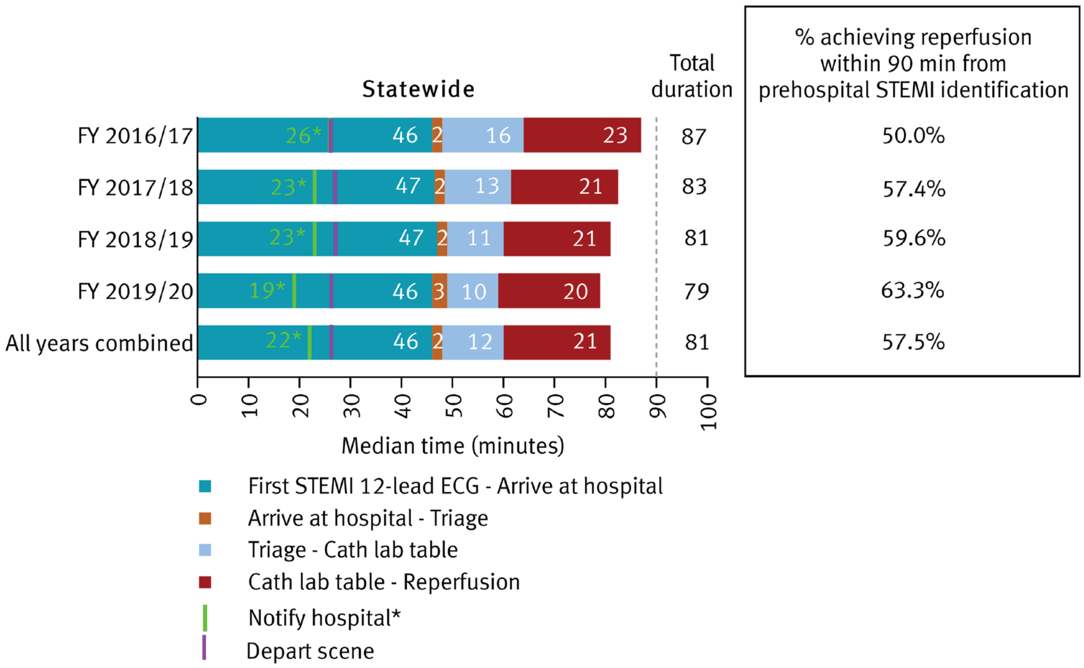


Figure 12. Statewide median time from QAS first STEMI 12-lead ECG to reperfusion in QAS direct PCI referral patients, and percentage of those patients who achieved reperfusion within 90 minutes following prehospital STEMI identification. *For FY 2016/17, 2017/18, 2018/19, it is time of notifying Emergency Department; for FY 2019/20, it is time of calling the interventional cardiologist to refer the patient for PCI.

7 Survival outcomes

Mortality in STEMI patients remains very low, with 30-day all-cause mortality rates of 2.3% in prehospital fibrinolysis patients and 0.9% in direct PCI referral patients for FY 2019/20 (Figure 13). Our data do not allow reporting of outcomes other than mortality, and in turn do not consider clinical sequalae such as heart failure and unplanned cardiac readmissions. Though, it would be expected that earlier treatment of STEMI patients would lower this complication burden.

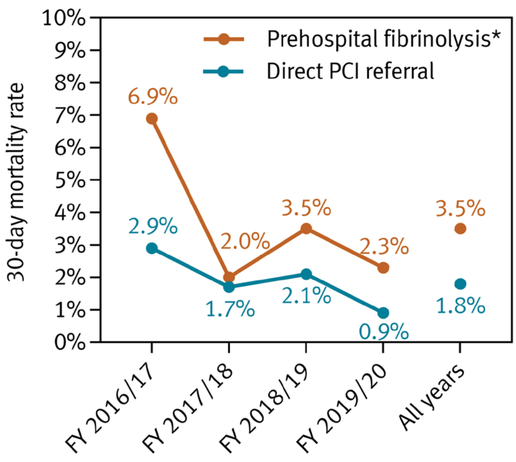


Figure 13. 30-day all-cause mortality rate by QAS prehospital reperfusion pathway.
*Excludes intra-arrest fibrinolysis.

8 STEMI patients suffering OHCA and receiving prehospital intra-arrest fibrinolysis

Intravascular thrombosis plays a fundamental role in the pathophysiology of cardiac arrest.[2] Underlying acute coronary disease (such as STEMI) and pulmonary embolism are responsible for around 50-70% of OHCA.[3,4] As such, there is a biological rationale for using fibrinolysis during an arrest. However, evidence on the benefits of routine administration of fibrinolytic therapy during an arrest remains inconclusive. Animal experiments,[5] case reports,[6] small retrospective[7] and prospective studies,[8] and a meta-analysis[9] have demonstrated a survival benefit of intra-arrest fibrinolysis; whereas a large randomised-controlled multicentre trial (Thrombolysis in Cardiac Arrest, TROICA) failed to confirm such a benefit.[10] Despite the very low-certainty evidence, current CPR guidelines recommend fibrinolytic drugs for cardiac arrest caused by suspected pulmonary embolism (weak recommendation);[11] whereas additional data on the benefits of intra-arrest fibrinolysis in cardiac arrests of suspected STEMI (and acute coronary disease in general) remain to be established. Within the QAS, intra-arrest fibrinolysis with tenecteplase is considered on a case-by-case basis based on patient's clinical characteristics and with strict approval from the QAS on-call consultant physician. The general principle is that fibrinolysis will only be considered for those patients who fail standard advanced cardiac life support in the setting of a suspected STEMI, or patients with a very high likelihood for pulmonary embolism as the cause of the cardiac arrest.

In this analysis, we investigated the epidemiology and survival outcomes in STEMI patients who suffered OHCA and received prehospital intra-arrest fibrinolysis with tenecteplase. To increase the sample size, we included all intra-arrest fibrinolysis cases from 1 July 2013 (the first intra-arrest fibrinolysis case was recorded in April 2013) to 30 June 2020.

Table 1. Patient characteristics

Variable	Number (%)
Age (median, IQR), years	53 (49-60)
Male	27 (87.1%)
Location of arrest[*]	
Private residence	18 (64.3%)
Other[ξ]	10 (35.7%)
Witnessed arrest	
Paramedic	19 (61.3%)
Bystander	10 (32.3%)
Bystander CPR	9 (29.0%)
Bystander defibrillation	2 (6.5%)
Initial shockable rhythm	22 (71.0%)
Paramedic defibrillation	25 (80.6%)
Number of shocks[‡] (median, IQR)	5 (2-12)
No-flow duration (median, IQR), minutes	0 (0-0)
Advanced airway management	25 (80.6%)
Adrenaline administration	30 (96.8%)
Amiodarone administration	18 (58.1%)
Aspirin administration	11 (35.5%)
Intra-arrest fibrinolysis regimen	
Tenecteplase only	10 (32.3%)
Tenecteplase + heparin	15 (48.4%)
Tenecteplase + enoxaparin	6 (19.4%)
Tenecteplase dose (mean, SD), milligrams	42 (7.5)
Time from arrest to fibrinolysis (median, IQR), minutes	22 (13-32)
ROSC sustained to hospital arrival	12 (38.7%)
Discharged alive[τ]	7 (23.3%)
30-day survival	7 (22.6%)

[*] Unknown location type for 3 patients, who were excluded from the denominator.
[ξ] Nursing home (2), public place (1), QAS station (1), workplace (1), medical facility (3), and vehicle (2).
[‡] For defibrillation patients only.
[τ] Unknown survival status at discharge for one patient, who was excluded from the denominator.

During the study period, a total of 31 intra-arrest fibrinolysis cases with suspected STEMI were recorded, or 4 cases per year on average. Table 1 shows patient's characteristics. The median age was 53 years, and 87.1% of patients were male. The majority of arrests (93.6%) were witnessed by either bystanders or paramedics. Four-out-of-five patients (80.6%) were defibrillated by paramedics, receiving a median (IQR) of 5 (2-12) shocks. Adrenaline and amiodarone were administered to 96.8% and 58.1% of patients, respectively. One-third (32.3%) of patients received tenecteplase only without an adjunct anticoagulant (heparin or enoxaparin). Median (IQR) time from arrest to tenecteplase administration was 22 (13-32) minutes. The rates of event survival (return of spontaneous circulation [ROSC] that sustained to hospital arrival), survival to discharge, and survival to 30 days were 38.7%, 23.3%, and 22.6%, respectively. Owing to the retrospective nature of this analysis, a comparator was not available. Nevertheless, the event survival rate in this patient group (38.7%) is higher than that in resuscitation-attempted adult OHCA of cardiac aetiology during the same study period (31.4%).

The median (IQR) time from arrest to sustained ROSC, and from tenecteplase administration to sustained ROSC, were 47 (27-66) and 12 (5-29) minutes, respectively. Figure 14 shows timestamps of the individual patients. Only one patient experienced bleeding following fibrinolysis administration (from airway without any other external haemorrhage).

Most patients featured here suffered witnessed arrests, had very short collapse to CPR times, and an initial shockable rhythm. This indicates a need for clinicians to consider the merits of intra-arrest fibrinolysis based on individual patient characteristics and the circumstances leading to their presenting condition. Lives can be saved with the timely administration of intra-arrest fibrinolysis, but candidates should be selected with great care. This may be best delivered in systems where clinicians at scene are supported by expert medical advice, allowing clinicians to recognise and treat this small but important group of survivors.

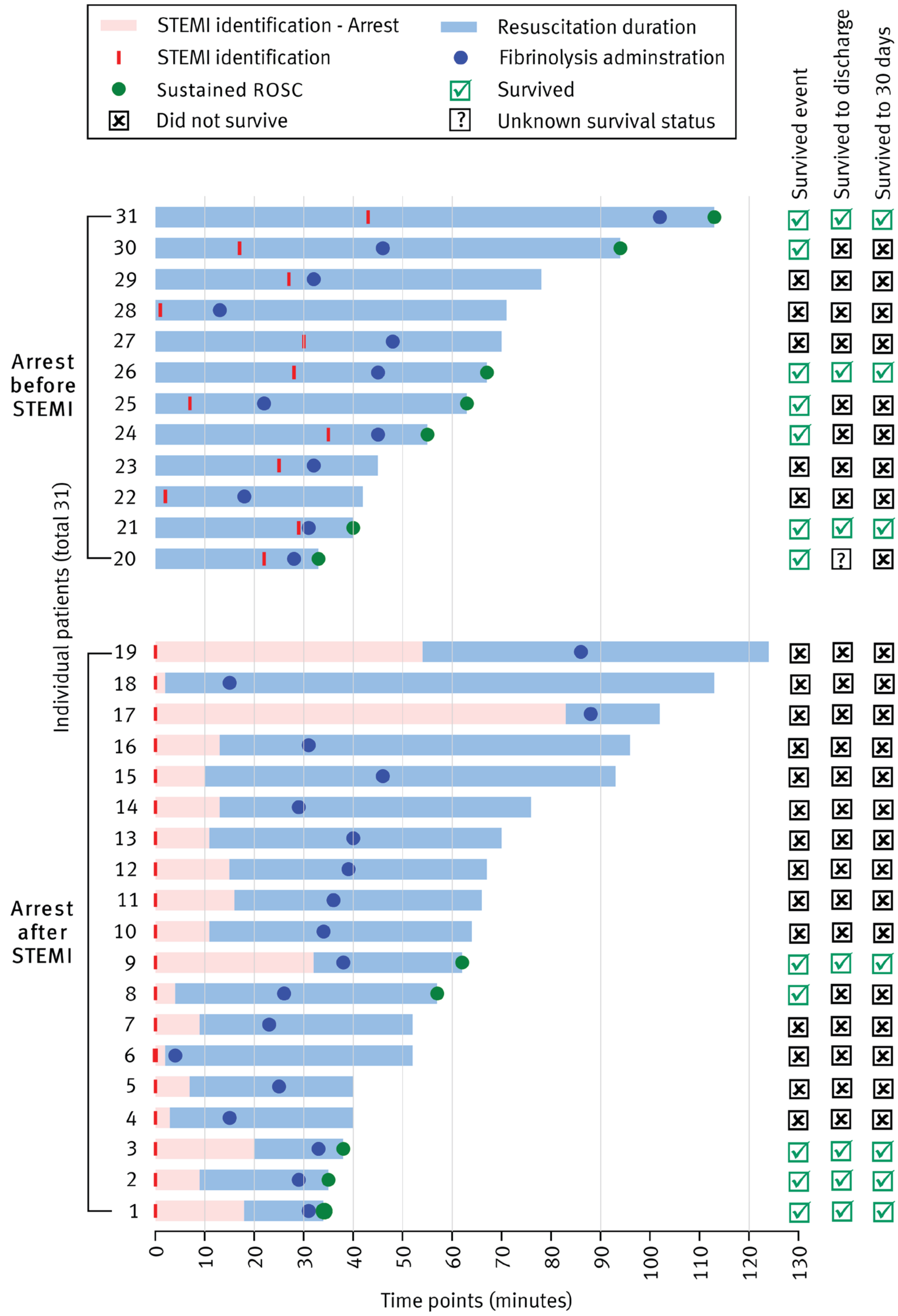


Figure 14. Timestamps of individual intra-arrest fibrinolysis patients.

9 STEMI patients suffering OHCA and treated with primary PCI

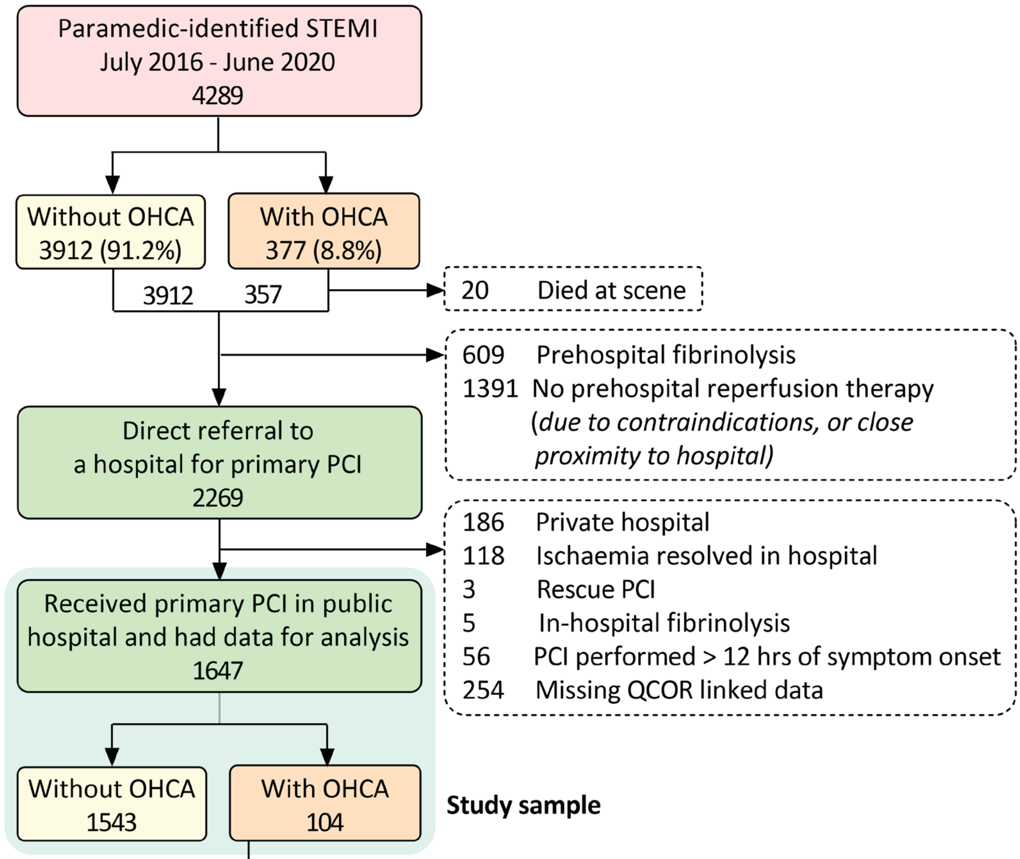
STEMI is a common cause of OHCA, and therefore urgent restoration of the coronary blood flow is an important treatment goal for these patients. For STEMI patients with resuscitated OHCA, international guidelines recommend immediate coronary angiography with subsequent primary PCI, if indicated.[12,13] In fact, early angiography and PCI are now considered a key component of post-resuscitation care for this patient group.[14]

To date, there remains a scarcity of data on the prognosis of STEMI patients treated with primary PCI after resuscitated OHCA. The limited number of studies in this area have included only patients with successful prehospital resuscitation (ROSC that sustained to hospital arrival) and STEMI subsequently diagnosed in the in-hospital setting.[15-18] STEMI identified and treated by paramedics in the field before direct transport to the hospital for primary PCI have been neglected in the literature.

This analysis included all paramedic-identified adult STEMI patients (aged $\geq$18 years) in Queensland between 1 July 2016 and 30 June 2020, who were directly referred by paramedics to a public hospital for primary PCI, subsequently received primacy PCI, and had ambulance and linked hospital records. The study sample was divided into two groups: with and without OHCA. Patient's characteristics and survival outcomes were described and compared between the two groups.

Patient demographics, prehospital times, and clinical and procedural data relating to prehospital STEMI management were obtained from the QAS STEMI database. OHCA status of STEMI patients and OHCA-specific variables were obtained from the QAS OHCA database. Additional clinical characteristics, angiographic profiles, and in-hospital procedures and times were obtained from QCOR. Record of death and date of death were derived from the Queensland Registry of Deaths.

Between July 2016 and June 2020, a total of 1647 STEMI patients were identified and treated in the field by paramedics, then directly referred to a public hospital for primary PCI, and subsequently received primary PCI. Figure 15 shows how the study sample was derived. Characteristics of the included patients are shown in Table 2. Right coronary artery was the most common culprit vessel (48.6% of patients), followed by the left anterior descending artery (40.5%) and circumflex coronary artery (15.5%). Single and double vessel disease was found in 90.6% and 7.8% of patients, respectively. Median (IQR) time from paramedic arrival at scene to STEMI identification was 6 (4-9) minutes. Reperfusion was achieved after a median (IQR) interval of 38 (29-52) minutes following hospital arrival, and 87 (73-102) minutes following STEMI identification by paramedics in the field.



OHCA-specific variable	n (%)$^{\pi}$
- Cardiac aetiology	103 (99.0%)
- Initial shockable rhythm	100 (96.2%)
- Defibrillated by paramedics	103 (99.0%)
- Number* of shocks by paramedics	1 (1-2)
- Paramedic-witnessed arrest	90 (86.5%)
- Bystander-witnessed arrest	13 (12.5%)
- Time (minutes)* from arrest to first paramedic resuscitation intervention	0 (0-1)
- ROSC at any time	103 (99.0%)
- ROSC sustained to hospital arrival	102 (98.1%)
- Time (minutes)* from arrest to sustained ROSC	3 (1-10)

Figure 15. Flowchart showing how the study sample was derived. $^{\pi}$Shown as number (percentage) unless indicated otherwise. *Shown as median (IQR).

Table 2. Comparison of characteristics between STEMI patients with and without OHCA

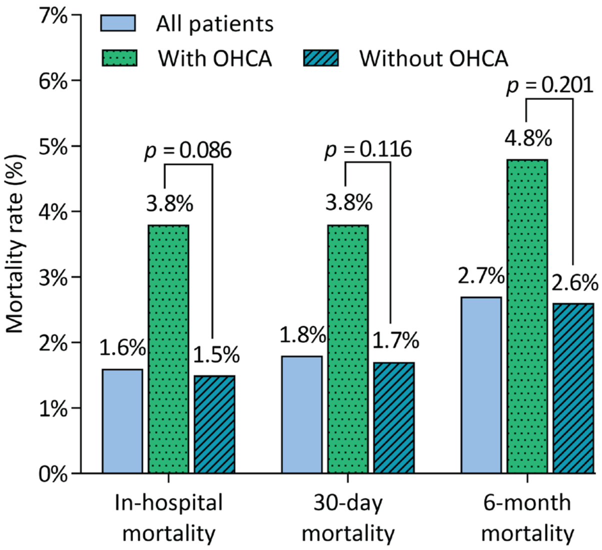
Variable	All patients	With OHCA	Without OHCA	*p*
Number of patients	1647	104	1543	
Age (median, IQR)	61 (53-71)	59 (50-66)	61 (53-71)	**0.032**
Female	344 (20.9%)	31 (29.8%)	313 (20.3%)	**<0.001**
Aboriginal and Torres Strait Islander‡	51 (3.1%)	2 (1.9%)	49 (3.2%)	0.774
Occluded artery*				
Left anterior descending artery	635 (40.5%)	62 (62.0%)	573 (39.1%)	**<0.001**
Circumflex coronary artery	243 (15.5%)	13 (13.0%)	230 (15.7%)	0.568
Right coronary artery	761 (48.6%)	31 (31.0%)	730 (49.8%)	**<0.001**
Left main coronary artery	12 (0.8%)	2 (2.0%)	10 (0.7%)	0.176
Posterolateral artery	20 (1.3%)	1 (1.0%)	19 (1.3%)	1.000
Posterior descending artery	13 (0.8%)	0 (0%)	13 (0.9%)	1.000
Marginal artery	27 (1.7%)	4 (4.0%)	23 (1.6%)	0.088
Diagonal	20 (1.3%)	1 (1.0%)	19 (1.3%)	1.000
Graft	14 (0.9%)	0 (0%)	14 (1.0%)	1.000
Number of diseased vessels*				0.064
One-vessel	1420 (90.6%)	86 (86.0%)	1334 (90.9%)	
Two-vessel	122 (7.8%)	14 (14.0%)	108 (7.4%)	
Three-vessel	19 (1.2%)	0 (0%)	19 (1.3%)	
More than three vessels	6 (0.4%)	0 (0%)	6 (0.4%)	
Body mass index category[µ,19]				0.887
Underweight (BMI < 18.5)	19 (1.2%)	2 (1.9%)	17 (1.1%)	
Normal (BMI 18.5 – 24.9)	411 (25.3%)	27 (26.0%)	384 (25.3%)	
Overweight (BMI 25 – 29.9)	684 (42.2%)	42 (40.4%)	642 (42.3%)	
Obese (BMI ≥ 30)	508 (31.3%)	33 (31.7%)	475 (31.3%)	
Cardiogenic shock prior to PCI procedure	27 (1.6%)	5 (4.8%)	22 (1.4%)	**0.024**
Time intervals (median, IQR), minutes				
Paramedic response time	10 (7-14)	10 (7-13)	10 (7-14)	0.659
On-scene time	33 (26-40)	36 (29-42)	33 (26-40)	**0.005**
FMC – STEMI identification	6 (4-9)	7 (4-14)	6 (4-9)	**0.005**
STEMI identification - reperfusion	87 (73-102)	93 (75-113)	87 (73-101)	**0.022**
Arrival at hospital – reperfusion	38 (29-52)	42 (29-58)	38 (29-51)	0.076

‡Unknown status for 15 patients (1 in the OHCA group, 14 in the without OHCA group). *Missing data for 80 patients (4 in the OHCA group, 76 in the without OHCA group); patient could have more than one occluded artery. µMissing data for 25 patients (all in the without OHCA group).

Of the included 1647 STEMI patients treated with primary PCI, 104 (6.3%) had OHCA. OHCA-specific variables of the 104 patients are shown in Figure 15. All arrests were of cardiac aetiology, with one exception. The majority of arrests had an initial shockable rhythm (100/104, 96.2%) and were witnessed by paramedics (90/104, 86.5%). Defibrillation by paramedics was administered to most patients (103/104, 99.0%) with a median (IQR) of 1 (1-2) shocks. Resuscitation treatment by paramedics was immediate with a median (IQR) of 0 (0-1) minute from collapse to first paramedic resuscitation intervention. Most patients (102/104, 98.1%) achieved ROSC that sustained to hospital arrival with median (IQR) time from collapse to sustained ROSC being 3 (1-10) minutes.

In comparison to those without OHCA, patients with OHCA were younger (median age 59 versus 61 years, $p = 0.032$) and more likely to be female (29.8 versus 20.3%, $p < 0.001$) (Table 2). The overrepresentation of females in the OHCA group may in part be attributable to previous observations that women are more likely to have atypical symptomatic presentations of acute coronary disease than men, delaying diagnosis and treatment.[20] STEMI patients with OHCA had significantly higher rates of cardiogenic shock prior to PCI procedure than in those without OHCA (4.8 versus 1.4%, $p = 0.024$). This finding is in agreement with previous studies and may be explained by the global myocardial dysfunction induced by the cardiac arrest.[21,22] In patients with OHCA, the left anterior descending artery was often the infarct-related artery. In contrast, the most common culprit artery in patients without OHCA was the right coronary artery (Table 2). Patients with OHCA had longer on-scene times (median 36 versus 33 minutes, $p = 0.005$), longer times from FMC to STEMI identification (median 7 versus 6 minutes, $p = 0.005$), and longer times from STEMI identification to reperfusion (median 93 versus 87 minutes, $p = 0.022$) (Table 2). This is likely due to the increased complexity associated with treating these patients.

Figure 16 compares all-cause mortality between the two groups. In-hospital, 30-day, and 6-month mortality was low, being 3.8%, 3.8% and 4.8% for STEMI patients with OHCA. The corresponding figures for those without OHCA were 1.5%, 1.7% and 2.6%, respectively. The differences in mortality rates between the two groups were not statistically significant. Our 6-month mortality rate of 4.8% in the prehospital STEMI with OHCA group is markedly lower than that reported by studies of hospital-diagnosed STEMI patients treated with primary PCI following OHCA (24% in Israel,[16] 46% France,[17,18] at least 25.7% the United States[14]), although our eligibility criteria for direct PCI referral may differ from those in the in-hospital setting. Furthermore, the arrest characteristics in our study differ from and are likely more favourable than those in these studies. All arrests in our study were witnessed by paramedics or bystanders; whereas 67% of arrests in French study[18] were witnessed. Furthermore, 77% of bystander-witnessed arrests in our study received bystander CPR; whereas the corresponding figure reported in the study in Israel[16] was 9%.



Number (%) of deaths	In-hospital mortality	30-day mortality	6-month mortality
All patients (n=1647)	27 (1.6%)	30 (1.8%)	45 (2.7%)
With OHCA (n=104)	4 (3.8%)	4 (3.8%)	5 (4.8%)
Without OHCA (n=1543)	23 (1.5%)	26 (1.7%)	40 (2.6%)

Figure 16. Mortality rates of paramedic-identified STEMI patients treated with primary PCI who suffered OHCA versus those who did not.

10 Conclusions

This report demonstrates the high standard of prehospital STEMI care that highly skilled QAS paramedics provide to patients in collaboration with interventional cardiologists and cardiac services statewide. The time interval between FMC and first 12-lead ECG is well within the 10-minute benchmark recommended by international guidelines. Almost two-thirds of patients received primary PCI within the ambitious international benchmark of 90 minutes following STEMI identification for the in-hospital setting. Mortality in all STEMI patients remains very low, demonstrating the effectiveness of our system that integrates prehospital care into the STEMI treatment cascade, allowing immediate access to definitive care. Mortality in paramedic-identified STEMI patients treated with primary PCI following resuscitated OHCA was low and similar to that of the average STEMI patient. This finding provides further support to the recommendation of emergency coronary angiography, and where indicated, primary PCI, for this important group of STEMI patients.

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12 References

1 Johns Hopkins Medicine. Anatomy and function of the coronary arteries. Available at https://www.hopkinsmedicine.org/health/conditions-and-diseases/anatomy-and-function-of-the-coronary-arteries

2 Dargin JM & Emlet LL. Thrombolysis during out-of-hospital cardiac arrest: a lesson in the law of diminishing returns. Crit Care. 2010; **14:** 304.

3 Silfvast T. Cause of death in unsuccessful prehospital resuscitation. J Intern Med. 1991; **229**: 331-35.

4 Spaulding CM et al. Immediate coronary angiography in survivors of out-of-hospital cardiac arrest. N Engl J Med. 1997; **336**: 1629-33.

5 Fischer M et al. Thrombolysis using plasminogen activator and heparin reduces cerebral no-reflow after resuscitation from cardiac arrest: an experimental study in the cat. Intensive Care Med. 1996; **22**: 1214-23.

6 Bozeman WP, Kleiner DM, Ferguson KL. Empiric tenecteplase is associated with increased return of spontaneous circulation and short-term survival in cardiac arrest patients unresponsive to standard interventions. Resuscitation. 2006; **69**: 399-406.

7 Javaudin F et al. Thrombolysis during resuscitation for out-of-hospital cardiac arrest caused by pulmonary embolism increases 30-day survival: findings from the French National Cardiac Arrest Registry. Chest. 2019; **156**: 1167-75.

8 Böttiger BW et al. Efficacy and safety of thrombolytic therapy after initially unsuccessful cardiopulmonary resuscitation: a prospective clinical trial. Lancet. 2001; **357**: 1583-85.

9 Li X et al. A meta-analysis of cardiopulmonary resuscitation with and without the administration of thrombolytic agents. Resuscitation. 2006; **70**: 31-6.

10 Böttiger BW et al. Thrombolysis during resuscitation for out-of-hospital cardiac arrest. N Engl J Med. 2008; **359**: 2651-62.

11 Soar J et al. Adult advanced life support: 2020 international consensus on cardiopulmonary resuscitation and emergency cardiovascular care science with treatment recommendations. Resuscitation. 2020; **156**: A80-119.

12 Ibanez B et al. 2017 ESC guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation: The Task Force for the management of acute myocardial infarction in patients presenting with ST-segment elevation of the European Society of Cardiology (ESC). Eur Heart J. 2018; **39**: 119-77.

13 Callaway CW et al. Part 8: Post-cardiac arrest care: 2015 American Heart Association guidelines update for cardiopulmonary resuscitation and emergency cardiovascular care. Circulation. 2015; **132**: S465-82.

14 Patel N et al. Trends and outcomes of coronary angiography and percutaneous coronary intervention after out-of-hospital cardiac arrest associated with ventricular fibrillation or pulseless ventricular tachycardia. JAMA Cardiol. 2016; **1**: 890-99.

15 Bendz B et al. Long-term prognosis after out-of-hospital cardiac arrest and primary percutaneous coronary intervention. Resuscitation. 2004; **63**: 49-53.

16 Marcusohn E et al. Primary percutaneous coronary intervention after out-of-hospital cardiac arrest: patients and outcomes. Isr Med Assoc J. 2007; **9**: 257-59.

17 Dumas F et al. Immediate percutaneous coronary intervention is associated with better survival after out-of-hospital cardiac arrest: insights from the PROCAT (Parisian Region Out of hospital Cardiac ArresT) registry. Circ Cardiovasc Interv. 2010; **3**: 200-7.

18 Garot P et al. Six-month outcome of emergency percutaneous coronary intervention in resuscitated patients after cardiac arrest complicating ST-elevation myocardial infarction. Circulation. 2007; **115**, 1354-62.

19 Australian Government Department of Health. Body mass index. Available at http://healthyweight.health.gov.au/wps/portal/Home/get-started/are-you-a-healthy-weight/bmi/

20 DeVon HA, Mirzaei S, Zègre-Hemsey J. Typical and atypical symptoms of acute coronary syndrome: time to retire the terms? J Am Heart Assoc. 2020; **9**: e015539.

21 Arabi AR et al. Clinical profile, management, and outcome in patients with out-of-hospital cardiac arrest and ST segment elevation myocardial infarction: insights from a 20-year registry. Angiology. 2018; **69**: 249-55.

22 Jentzer JC, Chonde MD, Dezfulian C. Myocardial dysfunction and shock after cardiac arrest. Biomed Res Int. 2015; **2015**: 314796.

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