

## Clinical Outcomes of Pharmaco-invasive ST-elevation Myocardial Infarction Management in a Large Australian Regional Centre

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### ABSTRACT

**BACKGROUND:** Primary percutaneous coronary intervention (PCI) is the standard of care for ST-elevation myocardial infarction (STEMI). In rural and remote centres with limited facilities, a pharmaco-invasive approach with thrombolysis followed by transfer of patients to PCI-capable centres remains important. Contemporary Australian data regarding pharmaco-invasive STEMI management are lacking. The primary objective of this study was to examine the clinical outcomes of pharmaco-invasive STEMI management in Bendigo, a large Australian regional centre.

**METHODS:** A retrospective analysis was performed for all patients presenting to Bendigo Health with an admission diagnosis of STEMI in the emergency department, between February 2013 and January 2014. During the study period, 68 consecutive patients received an admission diagnosis of STEMI in the emergency department. Of these, 58 patients were actually diagnosed with STEMI due to obstructive coronary artery disease, and received thrombolysis. These

patients were divided into two groups: (1) Pharmaco-invasive local (Local) group: thrombolysis with subsequent coronary angiography locally in Bendigo; (2) Pharmaco-invasive transfer (Transfer) group: thrombolysis with immediate transfer for coronary angiography. Door-to-Needle time (DTN), Thrombolysis-to-Angiography time (TTA), transfer cost, and inpatient morbidity and mortality were collected.

**RESULTS:** DTN was more prolonged in the Local group ( $38 \pm 35$  minutes versus  $25 \pm 23$  minutes,  $p=0.135$ ). DTN < 30 minutes was achieved for 71% of patients in the Local group versus 77% in the Transfer group. DTN was significantly prolonged for patients who presented to a peripheral centre first ( $78 \pm 35$  minutes,  $p=0.013$ ). More patients in the Transfer group had TTA  $\leq 24$  hours (82% vs 60%,  $p=0.286$ ). Significantly more patients in the Transfer group were managed with PCI (79% vs 53%,  $p=0.014$ ). In comparison, more patients in the Local group were managed with medical therapy, and surgery, respectively (28%,  $p<0.05$ ; 20%,  $p<0.05$ ). Rates of inpatient mortality and total mortality at follow up were higher in the Local group (12% and 20% vs 7% and 10%). The cost of transfer per patient was significantly higher in the Transfer group (\$5094.10 vs \$1960.90).

**CONCLUSION:** Locally managed pharmaco-invasive STEMI management in Bendigo, Australia, was associated with a higher proportion of patients waiting > 24 hours for angiography, and a significantly higher proportion of patients being managed by surgery and medical therapy. In a contemporary regional Australian pharmaco-invasive STEMI cohort, significant opportunities existed to improve patient outcomes.

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**Key words:** ST-elevation myocardial infarction; Thrombolysis; Pharmaco-invasive strategy; Door-to-Needle time; Regional and Rural Centre

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## INTRODUCTION

ST-elevation myocardial infarction is associated with a high rate of morbidity and mortality. In metropolitan centres with 24/7 access to the cardiac catheterisation laboratory, the standard of care for ST-elevation myocardial infarction (STEMI) is primary percutaneous coronary intervention (PCI). In regional and rural centres, where there is a lack of dedicated cardiology services, thrombolysis followed by subsequent transfer of patients to PCI-capable metropolitan centres (“Pharmaco-invasive” Transfer) is the usual mode of care. In Bendigo, a large Australian regional centre, there is a dedicated cardiology service with a cardiac catheterisation laboratory that is currently funded to operate on a part-time basis. As a consequence, the management of STEMI in Bendigo is a unique model. Patients who present during normal working hours, receive thrombolysis, and undergo subsequent coronary angiography locally if they have successfully reperfused after thrombolysis (“Pharmaco-invasive” Local group). Other patients who present out of hours, with or without successful reperfusion, are transferred immediately to metropolitan centres (“Pharmaco-invasive Transfer” group). Occasionally, some patients presenting during working hours, when the cardiac catheterisation laboratory is available, may receive primary coronary intervention (“Primary PCI” group). We aimed to study the clinical outcomes of STEMI in this unique model of care, comparing the locally managed Pharmaco-invasive strategy versus Pharmaco-invasive transfer strategy. Factors that resulted in delay in thrombolysis and angiography were analysed. A cost-analysis for patients transferred to metropolitan centres was performed.

## METHODS

A retrospective analysis was performed for all patients presenting to Bendigo Health with an admission diagnosis of STEMI in the emergency department, between February 2013 and January 2014. This project was approved as a quality assurance project within the Department of Cardiology, Bendigo Health. During the study period, 68 consecutive patients received an admission diagnosis of STEMI in the emergency department. Of these, 58 patients were actually diagnosed with STEMI due to obstructive coronary artery disease, and received thrombolysis. These patients were divided into two groups: (1) Pharmaco-invasive local (Local) group: thrombolysis with subsequent coronary angiography locally in Bendigo; (2) Pharmaco-invasive transfer (Transfer) group: thrombolysis with immediate transfer for coronary angiography. Door-to-Needle time (DTN), Thrombolysis-to-Angiography time (TTA), and transfer cost were collected. Inpatient morbidity including bleeding, stent thrombosis, stroke, renal failure and infection was recorded. Bleeding was defined according to the BARC definition<sup>[1]</sup>. Renal failure was defined as creatinine rise > 44.2 micro-mol/L or more than or equal to 25% from baseline, or new requirement for renal support therapy. Mortality was analysed from hospital records, with an analysis of the mechanisms of death.

### Statistical analysis

Data were analysed using SPSS 16.0 (SPSS Inc., Chicago).

Differences between pharmaco-invasive local and transfer groups were analysed using the Chi-Square test for categorical data, and independent samples T test for numerical data.  $P < 0.05$  was considered statistically significant. Results for average/mean were expressed in terms of percentage  $\pm$  standard deviation.

## RESULTS

68 patients presented to Bendigo Health emergency department between February 2013 and January 2014 with an admission diagnosis of STEMI. 28 patients were in the Pharmaco-invasive Local group. 30 patients were in the Pharmaco-invasive Transfer group. 10 patients were excluded from the analysis: 3 patients had their diagnosis revised to Takotsubo cardiomyopathy during the admission; 5 patients were not thrombolysed and did not receive angiography (4 of these patients were not thrombolysed due to advanced age with co-morbidities and/or malignancies; 1 patient was not thrombolysed due to a recent stroke); 1 patient self-discharged from the emergency department prior to thrombolysis. Of note, during the study period, due to limited cardiac catheter laboratory availability, only one patient received primary PCI. He was a 64-year-old male patient presenting in Killip class I with an inferior STEMI. He had an occluded right coronary artery opened and fixed with three bare metal stents, with a door to balloon time of 40 minutes. A groin haematoma was the only complication. Because the primary objective of this study was to examine the clinical outcomes of pharmaco-invasive STEMI management, this patient was excluded from the analysis. Demographics and clinical profiles of the patients in the “Pharmaco-invasive Local” and “Pharmaco-invasive Transfer” groups are listed in Table 1.

### Demographics and clinical profiles

The baseline demographic profiles of patients in “Pharmaco-invasive Local” and “Pharmaco-invasive Transfer” groups were similar. There were more male than female patients in both groups. Many patients possessed one or more risk factors for coronary artery disease. The three commonest risk factors were: hypertension, smoking and dyslipidaemia. Inferior/Inferolateral/Inferoposterior STEMI made up the highest proportion of STEMI presentation in both groups (61% in Pharmaco-invasive Local; 57% in Pharmaco-invasive Transfer), followed by anterior STEMI (36% in Pharmaco-invasive Local; 43% in Pharmaco-invasive Transfer). On presentation, the majority of patients belonged to Killip class I (75% in Pharmaco-invasive Local; 67% in Pharmaco-invasive Transfer). A smaller, but clinically significant, number of patients presented with STEMI in Killip class IV (11% in Pharmaco-invasive Local; 13% in Pharmaco-invasive Transfer).

### Door-to-Needle Time

Tenecteplase was the standard thrombolytic used for all patients reported in this study. The mean DTNs for the entire cohort of patients in the Pharmaco-Invasive Local and Pharmaco-Invasive Transfer groups were  $38 \pm 35$  minutes and  $25 \pm 23$  minutes, respectively. The difference in mean DTN between the two groups was not statistically significant ( $P=0.135$ ). In the Pharmaco-invasive Local group, some patients presented to a peripheral centre first. The mean DTN for the sub-group of patients who presented to a peripheral centre first was  $78 \pm 35$  minutes, significantly longer than the mean DTN for the Pharmaco-invasive Transfer group ( $P=0.013$ ). Excluding the patients who presented to a peripheral centre first, the mean DTN for the Pharmaco-invasive Local group was  $24 \pm 23$  minutes.

<b>Table 1</b> Demographics and clinical profiles of patients in the “Pharmaco-invasive Local” and “Pharmaco-invasive Transfer” groups.		
	<b>Pharmaco-invasive Local (n=28)</b>	<b>Pharmaco-invasive Transfer (n=30)</b>
Age (years; mean ± standard deviation)	66 ± 13	65 ± 11
Sex (Number of patients, %)		
Male	21 (75)	26 (87)
Female	7 (25)	4 (13)
Cardiac risk factors (Number of patients, %)		
Smoking	18 (64)	12 (40)
Diabetes mellitus	5 (18)	7 (23)
Hypertension	21 (75)	21 (70)
Dyslipidaemia	15 (54)	13 (43)
Family history of IHD	11 (39)	3 (10)
Type of STEMI (Number of patients, %)		
Anterior/ Anterolateral	10 (36)	13 (43)
Inferior/Inferolateral/Inferoposterior	17 (61)	17 (57)
Right ventricular	1 (4)	
Killip Class (Number of patients, %)		
Class I	21 (75)	20 (67)
Class II	4 (14)	6 (20)
Class III	0 (0)	0 (0)
Class IV	3 (11)	4 (13)
Door-to-Needle time (minutes; mean ± standard deviation)		
Entire cohort	38 (35)	25 (23)
Patients first presenting to peripheral centres	78 (35)	Not applicable
Bendigo patients only	24 (23)	
Thrombolysis complications (Number of patients, %)	0	3 (11)
Cath lab availability (Number of patients, %)	12 (43)	1 (3) * CCU bed not available
Thrombolysis to angiography time (Number of patients, %)		
≤24 hours	15 (60)	18 (82)
>24 hours	10 (40)	4 (18)
Angiography access (Number of patients, %)		
Right femoral artery (RFA)	25 (100)	24 (83)
Right radial artery (RRA)	0 (0)	5 (17)
Management strategies (Number of patients, %)		
PCI	13 (52)	23 (79.3)
Bare metal stent (BMS)	12 (48)	8 (28)
Drug eluting stent (DES)	1 (4)	15 (52)
Medical Therapy	7 (28)	3 (10)
Surgery		
Coronary artery bypass surgery (CABG)	5 (20)	2 (7)
Aortic valve replacement (AVR)	0 (0)	1 (3)
Lesion type (Number of patients, %)		
Left anterior descending (LAD)	4 (16)	11 (38)
Left circumflex (LCx)	3 (12)	3 (10)
Right coronary artery (RCA)	8 (32)	11 (38)
Other:		
Triple vessel disease	6 (24)	2 (7)
Minor coronary artery disease	4 (16)	2 (7)
Severe aortic stenosis		1 (3)
Transfer (Number of patients, %)	7 (28)	30 (100)
Transfer cost (\$ AUD)		
Total cost	7,843.59	112,070.18
Cost per patient	1,960.90	5094.10
Inpatient morbidity (Number of patients, %)		
Infection (Urinary tract infection, pneumonia, other)	3 (12)	4 (13)
Bleeding		
Type 1	4 (16)	3 (10)
Type 2	1 (4)	2 (7)
Type 3		2 (7)
Stroke	0 (0)	1 (3)
Renal failure	2 (8)	4 (13)
Requiring renal support therapy	0 (0)	2 (7)
Stent thrombosis	0 (0)	0 (0)
Mortality (Number of patients, %)		
Inpatient mortality	3 (12)	2 (7)
Total mortality	5 (20)	3 (10)
Average follow up period (months)	11	11

In the Pharmaco-invasive Local group, for the patients who presented to a peripheral centre first, all patients were assessed by general practitioners or non-specialist medical staff. For 50% of the patients in this group (3/6), thrombolysis was given only after the initial troponin result became available. For the patients who presented to Bendigo Health: 71% of the patients (12/17) achieved DTN < 30 minutes; DTN was ≥ 30 minutes for 29% (5/17) of the patients. In the Pharmaco-invasive Transfer group, all patients presented directly to Bendigo Health: 77% of the patients (20/26) achieved DTN < 30 minutes; DTN was ≥ 30 minutes for 23% (6/26) of the patients.

**Prolonged Door-to-Needle Time**

In the Pharmaco-invasive Local group, 29% of the patients (5/17) had DTN ≥ 30 minutes. The mean DTN for this sub-group of patients with prolonged DTN was 52 ± 24 minutes. In the Pharmaco-invasive Transfer group, 23% of the patients (6/26) had DTN ≥ 30 minutes. The mean DTN for this sub-group of patients with prolonged DTN was 54 ± 33 minutes. The reasons for prolonged DTN for the individual patients are listed in Table 2.

**Thrombolysis complications**

There were no documented complications from thrombolysis in the Pharmaco-invasive Local group. Three patients (11%) in the Pharmaco-invasive Transfer group developed complications from thrombolysis: 2 patients developed haematemesis requiring invasive treatment; 1 patient developed dental bleeding that was managed conservatively (*P*=0.68).

**Cardiac catheter laboratory availability**

Cardiac catheter laboratory was staffed during day-time working hours on the day of presentation for 43% of the patients (12/28) in the Pharmaco-invasive Local group, compared to 3% of the patients (1/30) in the Pharmaco-invasive Transfer group (*P*<0.05). The only patient in the Pharmaco-invasive Transfer group who presented on a day that the catheter laboratory was available did not have access to primary PCI due to unavailability of coronary care unit bed.

**Thrombolysis-to-Angiography Time (TTA)**

Thrombolysis-to-Angiography Time was defined as the time delay between the administration of thrombolytic and performance of coronary angiography. 25 patients in the Pharmaco-invasive Local group proceeded to angiography after thrombolysis. 3 patients did not receive angiography: 2 patients died (ventricular fibrillation;

cardiogenic shock), 1 patient had multiple co-morbidities and severe aortic stenosis. 29 patients in the Pharmaco-invasive Transfer group proceeded to angiography: 1 patient died in the catheter laboratory from electro-mechanical dissociation cardiac arrest prior to angiography. More patients in the Pharmaco-invasive Transfer group received coronary angiography ≤24 hours from thrombolysis, compared to Pharmaco-invasive Local group (82% versus 60%). 24% of the patients in the Pharmaco-invasive Local group (6/25) waited between 3 to 5 days for angiography due to unavailability of the catheter laboratory, compared to 2 patients in the Pharmaco-invasive Transfer group. The differences in TTA between the two groups were not statistically significant (*P*=0.286).

**Transfer of patients**

28% of patients in the Pharmaco-invasive Local group (7/25) were transferred to a tertiary centre after local coronary angiography for further management: 5 patients were transferred for inpatient CABG; 2 patients were transferred for complex PCI. In comparison, all patients in the Pharmaco-invasive Transfer group (30/30) were transferred: half the group was urgently transferred due to failed thrombolysis (persistent ST segment elevation with/without ongoing chest pain); the other half was transferred for angiography. Transfer cost was significantly higher for patients in the Pharmaco-invasive Transfer group than the Pharmaco-invasive Local group (Table 1).

**Management strategies**

Significantly more patients in the Pharmaco-invasive Transfer group were managed with PCI compared to the Pharmaco-invasive Local group (79% vs 53%, *p*=0.014). There was a significantly higher use of drug eluting stent in the Pharmaco-invasive Transfer group (52% vs 4%, *p*=0.003). In comparison, more patients in the Pharmaco-invasive Local group were managed with medical therapy, and surgery, respectively (28%, *p*<0.05; 20%, *p*<0.05).

**Morbidity and mortality**

Similar rates of infection and bleeding were observed between the two groups, whereas there was a higher rate of stroke and renal failure in the Pharmaco-invasive Transfer group (Table 1). Stent thrombosis did not occur in either group. Rates of inpatient mortality and total mortality at follow up were higher in the Pharmaco-invasive Local group than the Pharmaco-invasive Transfer group (12% and 20% versus 7% and 10%) (Table 1). Table 3 presents an analysis of the mortality cases.

**Table 2** Case analysis of the factors leading to prolonged Door-to-Needle time ≥ 30 minutes for the patients in both Pharmaco-invasive Local and Pharmaco-invasive Transfer groups.

Case number	Pharmaco-Invasive Local	Pharmaco-Invasive Transfer
1	Delay due to patient being pain free on presentation, but persistent ST elevation and chest pain occurred within 12 hours of presentation (DTN: 32 minutes)	Delay due to communication difficulties with history of muscular dystrophy (DTN: 31 minutes)
2	Delay due to discussions with both ED physician and cardiologist: patient had chest pain for 10 hours and was on enoxaparin for deep vein thrombosis (DTN: 40 minutes)	Delay due to atypical presentation with shortness of breath (DTN: 34 minutes)
3	Delay due to patient being in acute pulmonary oedema on presentation and management with non-invasive ventilation (DTN: 45 minutes)	Delay due to subtle ECG changes initially (DTN: 33 minutes)
4	Delay due to prolonged presentation to first electrocardiogram (ECG) time (15 minutes) and initial non-diagnostic ECG (DTN: 50 minutes)	Delay due to transient ECG changes (DTN: 38 minutes)
5	Delay due to ST segment elevation < 1 mm in leads II, III initially; patient was assessed by an intern and initially treated as non-ST elevation myocardial infarction (DTN: 94 minutes)	Delay due to significant hypothermia and attempts at warming (DTN: 80 minutes)
6		Delay due to previous history of subdural haematoma (DTN: 110 minutes)

**Table 3** A case-based mortality analysis for the study cohort.

	Case 1	Case 2	Case 3	Case 4	Case 5
<b>Pharmaco-invasive Local</b>					
Mechanism of mortality	Unknown ? pulmonary embolus	Recurrent ventricular tachycardia/fibrillation	Cardiogenic shock	Malignant mesothelioma	Unknown
Survival period after STEMI presentation	17 days (Day 6 post CABG)	Death on day of presentation	1 day	6 months	7 months
<b>Pharmaco-invasive Transfer</b>					
Mechanism of mortality	Septic shock	Ventricular septal defect after STEMI	Electro-mechanical dissociation arrest	N/A	N/A
Survival period after STEMI presentation	61 days	2 days	Death on day of presentation	N/A	N/A

## DISCUSSION

There is a high burden of cardiovascular disease in Australia. This disease burden is even higher in the rural and regional parts of Australia, compared to metropolitan areas<sup>[2]</sup>. National and international guidelines recommend primary PCI within 90 minutes of presentation to a PCI-capable hospital for acute STEMI<sup>[3-5]</sup>. However, this target is often difficult to achieve in the real-world, due to various delays and lack of access and availability of the cardiac catheter laboratory. There remains a role for pharmaco-invasive strategy in STEMI management, with timely thrombolysis in patients without contraindications, followed by early coronary angiography<sup>[6]</sup>. A large prospective study in the United States demonstrated that half-dose thrombolytic combined with immediate transfer for PCI was a safe and effective strategy for STEMI patients with expected delays to PCI due to long-distance transfer. Despite a significantly longer door-to-balloon time, there were no significant differences in 30-day mortality, major bleeding or re-infarction/ischaemia between the pharmaco-invasive and primary PCI groups<sup>[7]</sup>. A recent large French analysis demonstrated similar five-year survival rates for STEMI patients managed by a pharmaco-invasive approach compared to primary PCI (88% versus 85%)<sup>[8]</sup>. However, local Australian data are limited regarding the outcomes of pharmaco-invasive STEMI management in the contemporary era. A recent small retrospective study of 68 patients presenting with STEMI in rural Australia showed that thrombolysis results and outcomes in small rural emergency departments led by general practitioners were similar to a larger regional physician-led emergency department<sup>[9]</sup>. This study encouraged greater support for general practitioners to encourage the timely provision of thrombolytic treatment for STEMI patients presenting to small rural centres by general practitioners<sup>[9]</sup>. We aimed to contribute to the currently limited local Australian data on pharmaco-invasive STEMI management by studying the clinical outcomes of a real-world cohort of STEMI patients managed by pharmaco-invasive approach in the regional centre of Bendigo in the state of Victoria, Australia.

The mean DTN for patients in the Pharmaco-invasive Local group was more prolonged than the Pharmaco-invasive Transfer group (38 ± 35 minutes versus 25 ± 23 minutes). Guidelines recommend a target of DTN within 30 minutes<sup>[4,5]</sup>. DTN < 30 minutes was achieved for 57% of the entire cohort in the Pharmaco-invasive Local group versus 77% in the Pharmaco-invasive Transfer group. The mean DTN in the Pharmaco-invasive Local group was affected by patients who presented to a peripheral centre first. The mean DTN for this sub-group of patients was suboptimal at 78 ± 35 minutes. Excluding this sub-group, the mean DTN for the Pharmaco-invasive Local group was 24 ± 23 minutes, comparable to the Pharmaco-invasive Transfer group. Analysis of cases of prolonged DTN identified gaps in evidence based care (Table 2). For patients who presented to a

peripheral centre first, for 50% of the sub-group, thrombolysis was given only after the initial troponin result became available. Factors implicated in prolonged DTN included: (1) assessment by non-specialist medical staff or junior medical staff; (2) subtle or transient ECG changes; (3) atypical presentation of STEMI with pulmonary oedema; (4) concerns regarding potential contraindications to thrombolysis.

Rates of inpatient mortality and total mortality at follow up were higher in the Pharmaco-invasive Local group than the Pharmaco-invasive Transfer group (12% and 20% vs 7% and 10%) (Table 3). It was difficult to ascertain whether the mortality differences reflected differences in patient characteristics, or differences in the management pathways (Local versus Transfer). Significantly more patients were managed by PCI in the Pharmaco-invasive Transfer group (79.3% vs 52%). More patients in the Pharmaco-invasive Local group were managed with medical therapy and surgery (28% and 20% versus 10% and 10%). The differences in management may reflect different patterns of disease between the two groups. There was a higher thrombolysis complication rate in the Pharmaco-invasive Transfer group (11%).

International guidelines recommend coronary angiography for STEMI patients within 24 hours after thrombolysis<sup>[4,5]</sup>. Australian guidelines recommend early coronary angiography after thrombolysis<sup>[3]</sup>. Transfer for PCI within 6 hours after thrombolysis has been shown to be associated with reduced ischaemic complications<sup>[10]</sup>. 60% of the patients in the Pharmaco-invasive Local group received coronary angiography ≤ 24 hours, compared to 82% in the Pharmaco-invasive Transfer group. Prolonged TTA in the Pharmaco-invasive Local group was mainly as a result of lack of availability of cardiac catheter laboratory: catheter lab was open on the day of presentation for 43% of patients only. In the Pharmaco-invasive Transfer group, four patients who successfully re-perfused after thrombolysis waited > 24 hours for angiography for logistical reasons. For example, if a stable thrombolysed patient was transferred on the weekend, angiography was delayed until Monday. In these instances, angiography was available if the patient became unstable.

Immediate transfer of thrombolysed patients to metropolitan centres was expensive. The average cost for transfer per patient in the Pharmaco-invasive Transfer group was \$5094.10. Despite excluding the transfer cost for seven privately insured patients, which was covered by the insurance, the total transfer cost in the Pharmaco-invasive Transfer group exceeded \$110,000.

The results of this study may have significant implications for other rural and regional centres, which rely on a pharmaco-invasive model of STEMI management. Our study demonstrated that STEMI remains a morbid condition with a high rate of mortality, especially for rural and regional patients. Addressing gaps in evidence-based care could provide opportunities for improvements in STEMI outcomes. First, all medical staff who potentially could be involved with STEMI in a cardiac care network, including small peripheral centres and non-



specialist staff and junior staff, should receive standardised education on the diagnosis and initial management of STEMI based on clinical findings and ECG. Timely initiation of thrombolysis, in consultation with a linked specialist cardiology service, could improve DTN time for rural and regional patients. Second, increasing resources should be devoted to establish regional centres of excellence with increased availability and access to cardiac catheter laboratories. This would reduce the significant costs involved in transferring patients with STEMI for coronary angiography, reduce the significant pressure placed on metropolitan centres, and reduce delays in thrombolysis to coronary angiography time for patients in rural and regional centres.

### Limitations

This study was a retrospective study performed in a single Australian regional centre. However, the types of patients encountered in this study cohort would be representative of patients encountered in the real-world in rural and regional Australia. Further studies on the clinical outcomes in other rural and regional centres in Australia practising pharmaco-invasive STEMI management would be warranted.

## CONCLUSION

Locally managed pharmaco-invasive STEMI management in Bendigo, Australia, was associated with a higher proportion of patients waiting > 24 hours for angiography, and a significantly higher proportion of patients being managed by surgery and medical therapy. In a contemporary regional Australian pharmaco-invasive STEMI cohort, significant opportunities existed to improve patient outcomes.

## CONFLICT OF INTERESTS

There are no conflicts of interest with regard to the present study.

## REFERENCES

- 1 Mehran R, Rao SV, Bhatt DL, Gibson M, Caixeta A, Eikelboom J, et al. Standardised bleeding definitions for cardiovascular clinical trials: a consensus report from the Bleeding Academic Research Program. *Circulation* 2011;123:2736-2747.
- 2 National Heart Foundation Media Releases 2014. Not so lucky

- country: snapshot shows hearts at far greater risk in the bush. Thursday August 14th, 2014. Available at: <https://www.heartfoundation.org.au/news-media/Media-Releases-2014/Pages/not-so-lucky-country.aspx>
- 3 Aroney CN, Aylward P, Kelly AM, Chew DP, Clune E, et al. Guidelines for the management of acute coronary syndromes 2006. *Medical Journal of Australia* 2006;184(8 Suppl):S9-29.
- 4 Steg PG, James SK, Atar D, Badano LP, Blomstrom-Lundqvist C, Borger MA, et al. ESC guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation. *European Heart Journal* 2012;33:2569-2619.
- 5 O'Gara P, Kushner FG, Ascheim DD, Casey DE, Chung MK, de Lemos JA, et al. 2013 ACCF/AHA guideline for the management of ST-elevation myocardial infarction. *J Am CollCardiol* 2013;61:e78-140.
- 6 Gershlick AH, Banning AD, Myat A, Verheugt FW, Gersh BJ. Reperfusion therapy for STEMI: is there still a role for thrombolysis in the era of primary percutaneous coronary intervention? *Lancet* 2013;382(9892):624-632.
- 7 Larson DM, Duval S, Sharkey SW, Garberich RF, Madison JD, Stokman PJ, et al. Safety and efficacy of a pharmaco-invasive reperfusion strategy in rural ST-elevation myocardial infarction patients with expected delays due to long-distance transfer. *European Heart Journal* 2012;33:1232-1240.
- 8 Danchin N, Puymirat E, Steg PG, Goldstein P, Schiele F, Belle L, et al. Five-year survival in patients with ST-segment-elevation myocardial infarction according to modalities of reperfusion therapy The French Registry on Acute ST-elevation and Non-ST-elevation Myocardial Infarction (FAST-MI) 2005 Cohort. *Circulation* 2014;129:1629-1636.
- 9 Kronos R, Radford P, Cunningham C, Kronos D, Haines HM. Thrombolysis for acute ST elevation myocardial infarction: a pilot study comparing results from GP led small rural health emergency departments with results from a physician led sub-regional emergency department. *Rural Remote Health* 2012;12:2013. Epub 2012 Jun 8.
- 10 Cantor WJ, Fitchett D, Borgundvaag B, Ducas J, Heffernan M, Cohen EA, et al. Routine early angioplasty after fibrinolysis for acute myocardial infarction. *N Engl J Med* 2009;360:2705-2718.

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